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Akron, Ohio Recycle Energy System Project

Brown, Vence and Associates
San Francisco, CA

Prepared for

California State Solid Waste Management Board
Sacramento

Apr 81

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This technical bulletin is one of a series of reports presenting information gathered in visits to resource recovery facilities around the United States. This study effort has been sponsored by the California State Solid Waste Management Board (CSSWMB). As a number of California resource recovery facilities approach the implementation stage, the CSSWMB has recognized the need to learn from existing projects. In late 1980, five sites were chosen and visited by staff members from Brown, Vence and Associates, consultants to the CSSWMB. These sites included both small and large scale facilities, a number of differing technologies, and projects in varying stages of implementation or operation. The subject of this technical bulletin is the Akron, Ohio RDF-dedicated boiler waste-to-energy project.

KEYWORDS: *Solid waste management, *Akron(Ohio), *Waste recycling, *Refuse derived fuels.

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AKRON, OHIO
RECYCLE ENERGY SYSTEM PROJECT

TECHNICAL BULLETIN

April, 1981

Prepared for:

STATE SOLID WASTE MANAGEMENT BOARD
State of California - The Resources Agency
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PREFACE

This technical bulletin is one of a series of reports presenting information gathered in visits to resource recovery facilities around the United States. This study effort has been sponsored by the California State Solid Waste Management Board (CSSWMB). As a number of California resource recovery facilities approach the implementation stage, the CSSWMB has recognized the need to learn from existing projects. In late 1980, five sites were chosen and visited by staff members from Brown, Vence and Associates, consultants to the CSSWMB. These sites included both small and large scale facilities, a number of differing technologies, and projects in varying stages of implementation or operation. The five sites were:

- Auburn, Maine
- Duluth, Minnesota
- Madison, Wisconsin
- Saugus, Massachusetts
- Akron, Ohio

The subject of this technical bulletin is the Akron, Ohio RDF-dedicated boiler waste-to-energy project.

ACKNOWLEDGEMENTS

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TABLE OF CONTENTS

INTRODUCTION 1

CHAPTER 1 - PROJECT ORIGIN

IDENTIFICATION OF NEED 3
KEY PARTICIPANTS 3
CHRONOLOGY 4
WASTE CONTROL ORDINANCE 5
FEDERAL, STATE, AND LOCAL REGULATIONS AND PERMITS 5

CHAPTER 2 - PROJECT DESCRIPTION

LOCATION 8
TYPE OF SYSTEM 8
PLANT DESIGN RATES 11
ACTUAL PLANT RATES 11
PHYSICAL PLANT AND STAFF 12

CHAPTER 3 - PROJECT FINANCES AND RISK ALLOCATION

METHOD OF FINANCE 18
FINANCIAL PERFORMANCE 18
RISK ALLOCATION 25

CHAPTER 4 - PROJECT EVOLUTION

PLANT RELIABILITY 27
MODIFICATIONS 27
IMPACT ASSESSMENT AND COMPLIANCE 29
SUCCESSES, FAILURES, REMEDIES 31
FUTURE DEVELOPMENTS 33

CHAPTER 5 - THE CALIFORNIA PERSPECTIVE

INTRODUCTION 34
PROJECT LOCATION 34
ASH DISPOSAL 34
AIR POLLUTION 34
WASTEWATER 35
STATE SOLID WASTE MANAGEMENT AGENCY 35
PERMIT PROCESS 35
CHOICE OF SYSTEM 36
OTHER CONSIDERATIONS 36

CHAPTER 6 - PROJECT EVALUATION

PROJECT BENEFITS 38
PROJECT-RELATED PROBLEMS 38
UNEXPLOITED OPPORTUNITIES 38
HINDSIGHT EVALUATION 38

APENDIX A - FIELD INSPECTION NOTES 39

APPENDIX B - BIBLIOGRAPHY 51

LIST OF TABLES

i-1	PROJECT FACT SUMMARY	2
1-1	AKRON CHRONOLOGY	6,7
2-1	DELIVERIES TO RES (FEBRUARY 1981)	8
3-1	RES PROJECT COSTS	19
3-2	RES DIRECT CONSTRUCTION COST BUDGET (OCTOBER 1979)	20
3-3	RES PROJECTION OF OPERATING RESULTS	21

LIST OF FIGURES

2-1	LOCATION OF AKRON, OHIO	9
2-2	LOCATION OF RES FACILITY	10
2-3	SITE PLAN	13
2-4	PROCESS FLOW DIAGRAM	14
2-5	MULTI-RAM DESIGN SKETCH	16
2-6	RES STAFF ORGANIZATION	17
3-1	FLOW DIAGRAM OF PROJECT FUNDS, 1980 PROJECTIONS	22
3-2	RES REVENUE DATA PROFILE	23
4-1	SAMPLE RES STEAM TABLE	30

INTRODUCTION

The Akron, Ohio, Recycle Energy System (RES) facility was designed to process 1,000 tons per day, seven days per week, of municipal solid waste from Akron and nearby towns in Summit County, Ohio. The plant is owned by the City of Akron, is operated by Teledyne National, and was designed by GPD Engineering. Refuse received at the plant is shredded, then light combustibles are separated for semisuspension burning in dedicated boilers. Ferrous metal is recovered from the heavy, noncombustible fraction. Steam, produced in the boilers to a maximum design rate of 378,000 lb/hr, is sold to BF Goodrich Company and other customers, including a downtown steam loop, for process heat and space heating. Although construction of the facility was completed in mid-1979, with shakedown and start-up planned to last three months, numerous operating difficulties have kept the plant in start-up operations from then until the present (April, 1981). There has been a steady increase in steam production as Teledyne and the City have identified and resolved these difficulties. Through the winter of 1980, the RES plant was able to serve fully the downtown steam loop. Currently, the plant processes about 4,000 tons per week of refuse. It is scheduled to be fully operational by the end of 1981.

Akron is a medium-sized city, population 275,000, located in northeastern Ohio; it is well-known as a tire manufacturing center. The RES plant is in downtown Akron, on land that was cleared as part of an urban renewal project. The site lies immediately adjacent to the BF Goodrich tire manufacturing complex.

Noteworthy in the evolution of the Akron project was the passage by the Akron City Council of a municipal waste control ordinance, which required all refuse collected in the City to be delivered to the plant. The bond underwriters insisted on the ordinance in order to make the bonds more saleable. Refuse haulers are challenging the law in court, as a test case concerning whether a municipality can mandate delivery of refuse to a resource recovery facility. The ordinance has been upheld in U.S. District Court, with a further appeal pending.

The City used federal revenue-sharing money to pay for preliminary feasibility studies. Design, construction and start-up of the RES plant was financed through issuance of $46 million in tax-exempt revenue bonds from the Ohio Water Development Authority and $10 million in general obligation bonds ($5 million from the City of Akron, $5 million from Summit County). At the advice of the underwriters, the general obligation bonds were added to the financing when difficulties arose in the sale of the revenue bonds. To date, $34.2 million has been spent on direct construction costs, and $17.4 million on engineering design, legal fees, construction management, and other indirect construction outlays. Expenditures for shakedown and start-up are continuing and will be substantially greater than expected. The City is exploring ways to refinance the project.

The project's principal source of revenue is steam sales; these account for about 75% of project revenues. Tipping fees also generate income, although these charges have been kept low, because the facility competes with several landfills for wastes from outside the city limits.

The City obtained the RES facility through a conventional procedure involving selection of an architectural/engineering firm, preparation of a design, and competitive bidding.

Principal facts about the Akron project are given in Table i-1.

Table i-1

AKRON FACT SUMMARY

Population:	275,000
Construction completed:	May, 1979
Shakedown:	Ongoing
Principals:	City of Akron - owner, principal source of refuse BF Goodrich - principal steam purchaser Teledyne National - operator GPD Engineering - project design and coordination Dillon, Read & Co. - underwriter Ohio Edison - former owner of downtown steam loop
Volume (design):	1,000 tons per day, seven days per week.
" (actual):	4,000 tons per week.
Technology:	RDF-dedicated boiler system, which includes: · Production of RDF with ferrous recovery, using horizontal-shaft shredders and air classifiers. · Combustion of RDF in semisuspension.
Product:	Steam - saturated at 560 psig, average production (October, 1980) almost 120,000 lb/hr.
Costs:	Financed with a $46 million revenue bond and $10 million in general obligation bonds ($5 million City of Akron, $5 million Summit County).
Capital Expenditures to Date:	· $34.2 million for direct construction costs. · $17.4 million for design, legal fees, construction management, and other indirect costs. · Approximately $5 million to date in start-up/shakedown costs.
Revenues:	· Sale of steam, contract prices from $1.83 to over $4.00 per M-lb. · $6.00 per ton tipping fees paid by refuse haulers. · Sale of recovered ferrous. · Income from reserve funds and notes.
Procurement:	Competitive bidding, architect/engineering approach.

IDENTIFICATION OF NEED

Landfill Need

In 1969, the City of Akron sited its present landfill at a location north of town, adjacent to Hardy Road. The Hardy Road siting caused numerous objections from the relatively few citizens who resided nearby. The City recognized that siting of the next landfill would be even more difficult, if not impossible, within a reasonable distance of the waste source. The life of the Hardy Road fill was then projected to be ten years; this estimate was increased markedly some years later. It was felt that alternatives to landfill, such as materials recovery programs, incineration, rail haul to distant landfill, etc., should be investigated. A July, 1971, study by the Akron Planning Department recommended "that the optimum long-term solution to the solid waste disposal problem is the construction of an efficient solid waste reduction facility, based on the principles of modern incineration."

Energy Need

The downtown area of Akron is served by a central steam line; steam was generated, until recently, at the Ohio Edison (OE) coal-burning plant on Beech Street. The system began operations in 1928. By the early 1970's, both the age of the plant and environmental legislation would have required a massive investment by OE to keep the system functioning. In February, 1971, OE petitioned the Ohio Public Utilities Commission (PUC) for permission to abandon its plant. Downtown steam users, faced with the prospect of purchasing their own individual heating systems, formed an ad hoc committee to oppose the abandonment. The petition was denied by the PUC and, in the process, major energy users (the downtown loop and BF Goodrich) became aware of, and supportive of, the waste-to-energy concept.

KEY PARTICIPANTS

The City of Akron

The City has taken the leadership role in this project's development. In a project of this size, it is difficult to single out one person who has coordinated all aspects of the effort; for Akron, the individual who has done the most in this regard is the Director of the Department of Planning and Urban Development, Mr. James Alkire. His efforts were instrumental in convincing City Council members of the need for the project and in obtaining adequate financing and steam markets. Because this department handles sizable urban development projects, it has grown to about 170 people. The large staff facilitated the City's initial work on the RES project. The City government has further supported the project with passage of its waste control ordinance, and with a $5 million general obligation bond providing funds for construction of the steam distribution system. City planning department and legal department staff performed negotiations for steam contracts, with assistance from Dillon, Read and Co., project underwriters.

BF Goodrich

All parties seem to agree that the key to this project's feasibility was BFG's willingness to purchase any and all available steam, up to BFG's total steam need, from the RES plant. BFG thus provides a virtually unlimited market. Their cooperation with and support of the project, throughout the design, construction, and shakedown periods, has been noteworthy.

Teledyne National

Teledyne became involved in the project during plant construction and is the plant operator. They bring to the project their experience in operating a waste processing/RDF producing plant in Baltimore County, Maryland. It should be noted that Teledyne did not participate in the design of this system. They are presently modifying various processes in the plant while it is in start-up.

GPD Engineering

Formerly known as Glaus, Pyle, Schomer, Burns and De Haven, GPD has a long history of work performed for the City of Akron, including its wastewater treatment plant. GPD has also designed several large-scale power plants located in central Ohio. For this project, GPD's first effort was a feasibility study of a "Recycle Energy System," produced in 1971 with money from BF Goodrich. Several features of that original design may be found in the existing RES plant. A sister plant designed by GPD is now in shakedown in Niagara Falls, New York. The chief difference between the Niagara plant and the Akron project is that cogeneration of electric power is an additional significant energy product in the New York facility.

Dillon, Read & Co.

This underwriting firm was consulted by the City when it became apparent that financing was not going smoothly. The local underwriting firm was having difficulty arranging the bond sale, and several other incidents, including the default of New York City and air pollution problems at the Nashville refuse combustion plant, were contributing to the problem. Dillon, Read insisted on several strengthening measures, including obligating the City and County for $5 million each in support above the basic $46 million bond issue; hiring an outside engineering firm, R.W. Beck, to evaluate the project's feasibility; and requesting the enactment of a city waste control ordinance.

Ohio Edison

The utility has turned over its Beech Street steam plant and all existing steam distribution lines to the City for $1. The steam plant is held in reserve as a back-up system; during shakedown at RES, two of the six boilers have been kept warm for quick start-up if necessary. They have not been used.

Akron Beacon-Journal

The city newspaper took an active role in first publicizing the need for a waste disposal/energy production alternative. The paper supported the RES project during planning and design stages and has provided close coverage of progress at the plant during start-up.

CHRONOLOGY

The order of events in the Akron project has been conventional. When the City recognized its dual problems of energy supply and waste disposal, several studies were done of both the basic problems and some contributing factors (such as the supply of waste throughout Summit County). An architectural and engineering firm was selected, a design was prepared, and bids were received. At this juncture, from late 1974 through early 1975, financing difficulties were encountered. It was not until November, 1976, that these were resolved; ground was broken shortly thereafter. Fortunately for the project, most bidders were able to hold their prices through that period.

Table 1-1 details the chronology of the Akron project.

CHAPTER 1 - PROJECT ORIGIN

WASTE CONTROL ORDINANCE

The evolution of the Akron project included the passage of a waste control ordinance by the City Council. As mentioned above, this ordinance was passed at the insistence of the project underwriters to assure potential bond purchasers of a waste supply for the plant. The ordinance stipulates that refuse which has been picked up by a hauler in Akron must be disposed "through the project." This prevents collectors under contract to the City from removing recyclable items prior to disposal at RES.

Local collection companies, with support from the National Solid Waste Management Association, are taking legal steps to overturn this ordinance. The loss of revenue from recycled material is one reason for the companies' resistance. Perhaps more importantly, the Akron ordinance is the strongest legal measure taken to date by a municipality to control waste for a resource recovery project; it is regarded as a test case. The ordinance was upheld in U.S. District Court. In part, the court ruled that the law did not violate federal anti-trust statutes, arguing that the agreement between the City and the Ohio Water Development Authority (OWDA) made the City an agent of the state and therefore, like the state, exempt from federal anti-trust laws. Appeals are pending, however.

FEDERAL, STATE, AND LOCAL REGULATIONS AND PERMITS

The permitting process for the RES facility was remarkably simple. Project consultants identified as necessary four permits and a determination of nonsignificant air deterioration. Federal permits were administered through the Ohio EPA, which at the time of permit application (early 1970's) was a relatively new agency. The major permit to be obtained from the Ohio EPA was a Construction Permit (Permit to Install). The plant was reviewed as a fuel-burning emissions source, as an incinerator, and as a solid waste disposal facility. Because permit applications were submitted in late 1975, New Source Review rules did not yet apply. Other required permits were the NPDES (waste-water discharge) permit, the USEPA Spill Prevention, Control and Countermeasures Plan (for onsite fuel oil handling), and the Ohio EPA Operating Permit. The last of these will not be obtained until the plant is in full operation and can be tested.

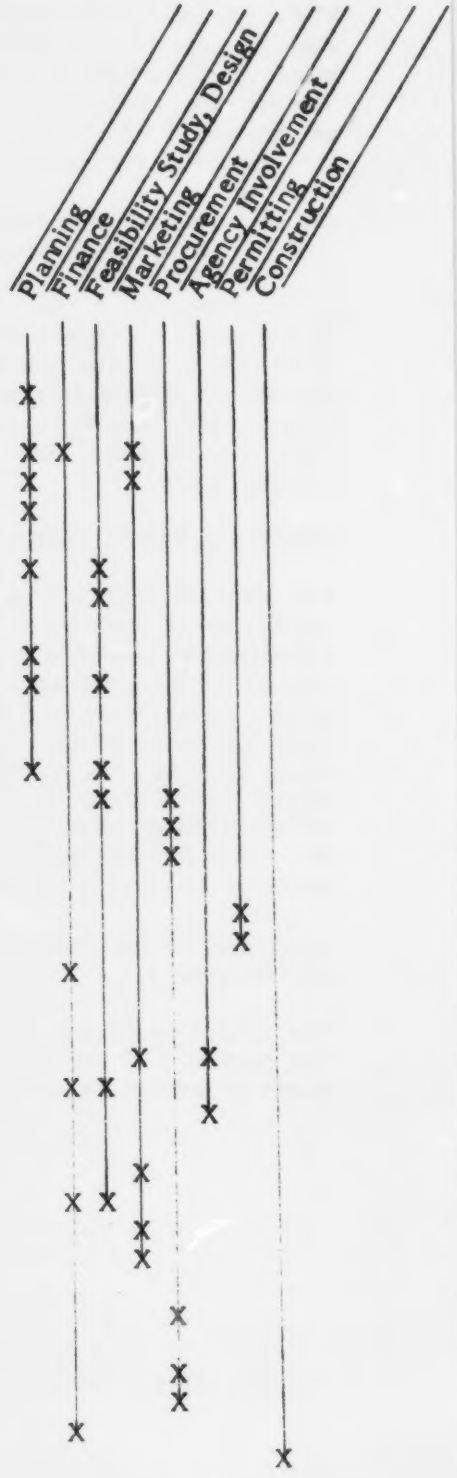
Local permits for building, fuel storage, etc., were obtained through City agencies in a routine manner.

The project location is not a particularly sensitive one. Regulatory agencies recognized that operation of the RES plant would eliminate or reduce operation of other much older steam production equipment, for a probable net reduction in atmospheric emissions.

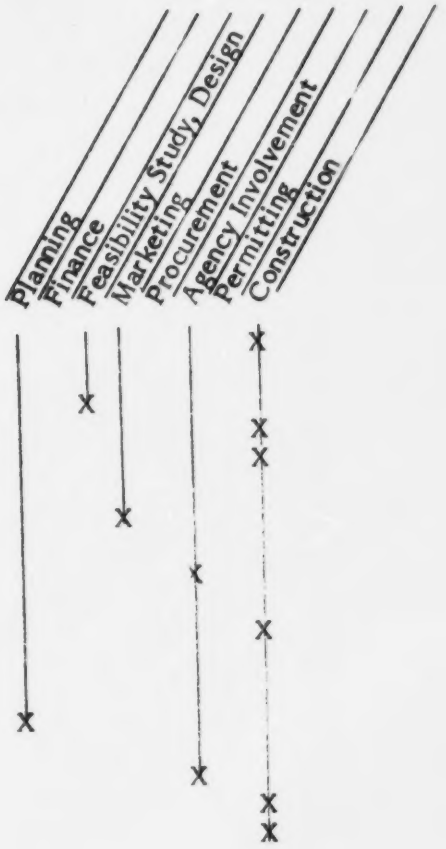
Table 1-1

AKRON CHRONOLOGY

Event	Date
Part I of Comprehensive . . . Study (Sanitary Landfill), by Akron Planning Department	August 1968
Hardy Road landfill opened	1969
BFG contacted by Planning Department	1970
OE petitions to abandon steam loop	1971
Comprehensive . . . Study completed	July 1971
Feasibility Study by GPD, paid for by BFG	August 1971
GPD authorized to do design	April, 1973
Solid Waste Disposal in Akron Summary Report, by Akron Planning Department	May 1974
Preliminary Phase Report by GPD	June 1974
Seven Akron City Council members visit St. Louis project, are convinced of RES feasibility	October 1974
GPD completes original bid documents	October 1974
Bids received	February 1975
Contracts awarded (subject to financing)	September 1975
Permit to Install application received by OEPA	December 1975
Permit to Install granted	March 1976
Dillon, Read join project team	July 1976
Ohio PUC conditionally authorizes OE to abandon steam service to Akron customers	August 1976
R.W. Beck hired by Akron	August 1976
Waste control ordinance passed	October 1976
Stream contracts with 26 steam loop customers	October 1976
Draft Feasibility Report by R.W. Beck	November 1976
Steam contract with University of Akron	November 1976
Steam contracts with City Hospital, BFG	November 1976
OE agrees to sell steam plant and lines to Akron	November 1976
Final construction and equipment bids accepted	December 1976
Teledyne signs contract to operate	December 1976
Bonds issued by OWDA	December 1976
Groundbreaking	December 1976



Event	Date
Construction begins	January 1977
Feasibility of . . . Rubber as Fuel, by Teledyne	September 1977
Shakedown begins	April 1979
First refuse processed (for testing)	July 1979
First steam sold, through Ohio Edison steam lines	July 1979
District court upholds waste control ordinance	December 1979
Citizens complain of odor and particulates	May-June 1980
The Supply of Solid Waste in Summit County, report by Akron Planning Department	August 1980
Application to DOE for price-support loan	August 1980
OE plant turned over to City of Akron	September 1980
University of Akron first receives steam	October 1980



CHAPTER 2 - PROJECT DESCRIPTION

LOCATION

Plant Location

The City of Akron, population 275,000, is located approximately 25 miles south of Cleveland, Ohio (see Figure 2-1). The Recycle Energy System plant is in downtown Akron, less than a mile from City Hall and immediately adjacent to BF Goodrich world headquarters, which includes manufacturing, research, and office buildings.

Figure 2-2 locates the facility with respect to BFG and its two other large steam customers, Akron City Hospital and the University of Akron. RES is located in the "Opportunity Park" urban renewal area, a former low-income residential section.

Wasteshed

All municipal refuse collected in the City of Akron is delivered to the plant. This is collected in part by the City and in part by franchisees. A waste control ordinance enacted by the City requires that all waste collected in Akron be brought to RES. In addition, a few surrounding communities find it economic to deliver to the plant. The City operates a landfill near its northern border; the City plans to close the landfill to all waste except RES combustion ash and process residue. Other towns near the landfill will then find it necessary to deliver to RES. For safety reasons, there is no provision for public drop-off at the plant; the City plans to provide one or more outlying transfer stations, where the public can deposit refuse for transport to RES. Table 2-1 summarizes deliveries to RES as of October, 1980.

Table 2-1

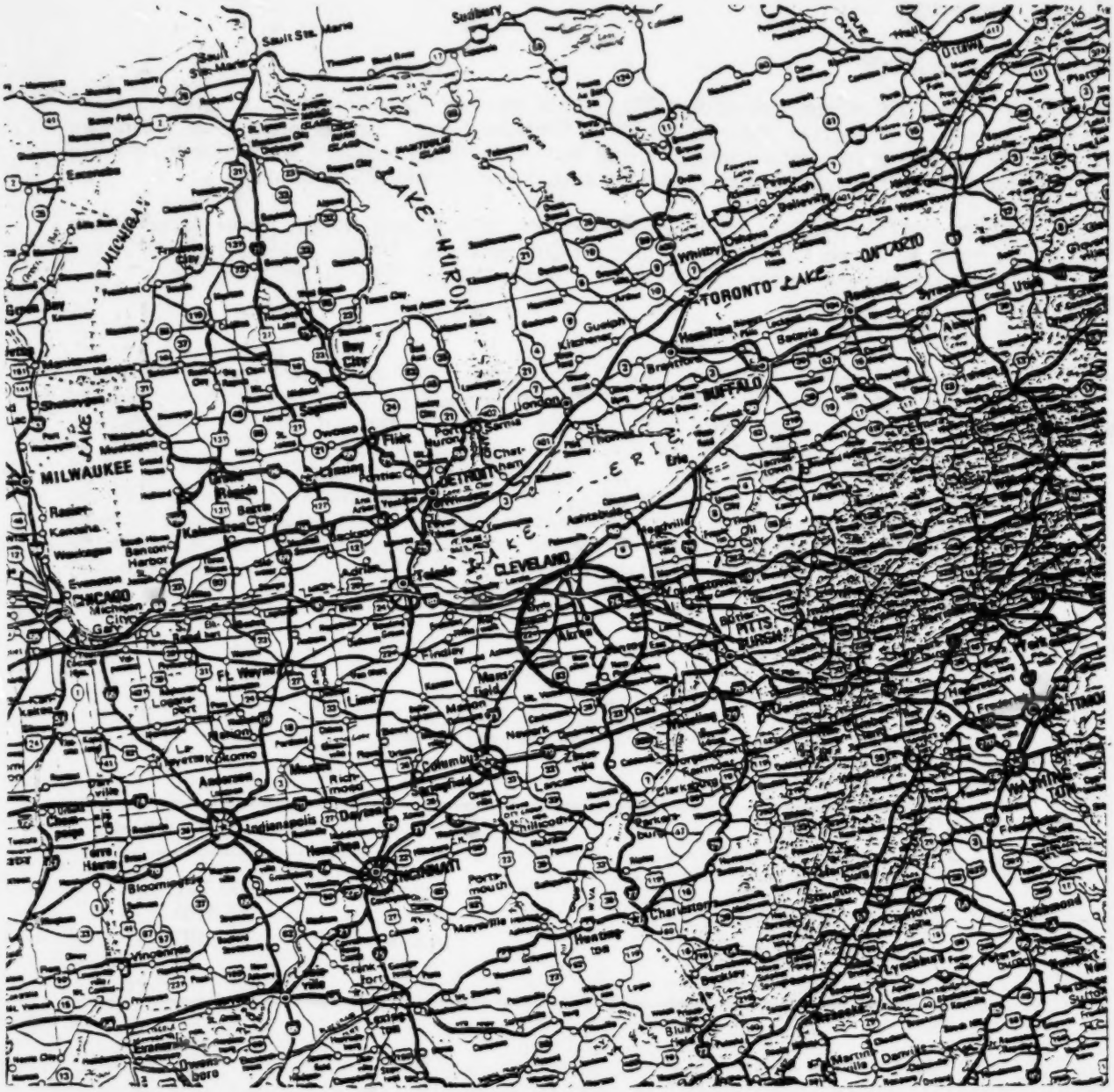
DELIVERIES TO RES
(February 1981)

Community		Tonnage (5-Day Basis)
City of Akron	approx.	700 TPD
Cuyahoga Falls	approx.	85 TPD
Wadsworth	approx.	25 TPD

TYPE OF SYSTEM

The Recycle Energy System produces a refuse-derived fuel (RDF). The RDF then is burned mainly in suspension, in boilers designed specifically for that purpose. In the resource recovery industry, this is known as an "RDF-dedicated boiler" system.

Arriving refuse trucks deposit waste in a receiving pit. The material is conveyed to a shredder, air classified after shredding, and the light combustibles fed to a storage bin. This fuel is metered from the bin and pneumatically conveyed to the boilers where it is burned, with as much as 80% of the burning taking place in suspension. In the boiler



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LOCATION OF AKRON

FIGURE 2-1

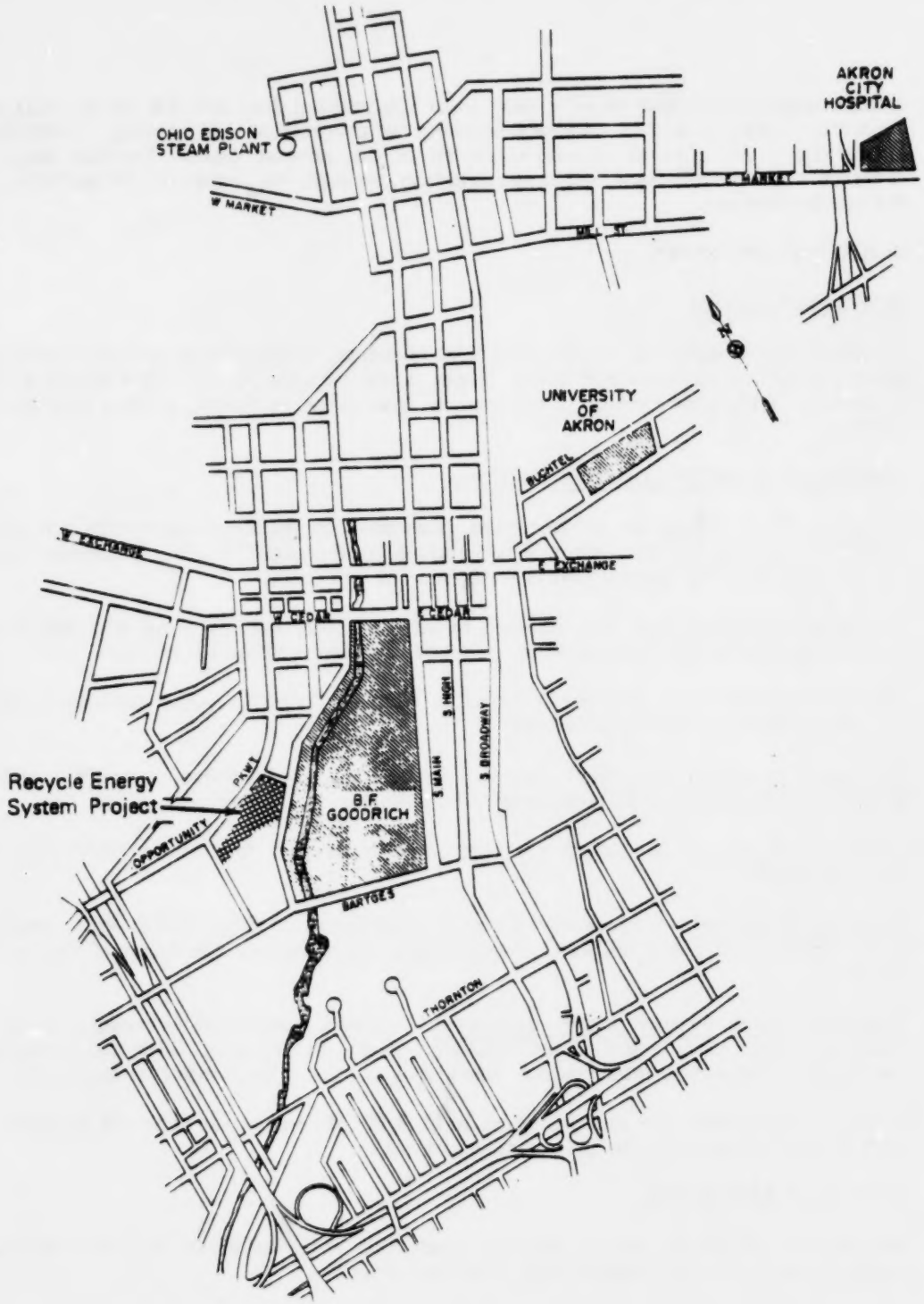


FIGURE 2-2

LOCATION OF RES FACILITY

walls, water-filled tubes receive heat from the burning fuel and the water boils under pressure. Steam is sold to various customers for process use and heating. Electrostatic precipitators are used to control emissions in the exhaust gases. Ferrous metals are removed from the air-classified heavy fraction and sold; the remainder is landfilled, as is the combustion ash.

PLANT DESIGN RATES

Processing Capacity

The plant was designed to process 1000 TPD of refuse, feeding three boilers, operating 24 hours per day, seven days per week. There is room on the site to add a fourth boiler if necessary. Refuse processing is designed to take place 16 hours per day, five days per week.

Feed Materials and Product Specifications

Certain kinds of refuse are not accepted. Examples of unacceptable wastes are building demolition residue (brick, plaster, etc.), pathogenic (hospital) or other hazardous wastes, and certain industrial wastes that are too bulky or too dusty.

For design purposes, RDF was assumed to have a higher heating value of 6,500 BTU/lb. In practice, the range of actual heating values has been 5,500-6,000 BTU/lb.

The steam produced by RES is saturated at 560 psig. Various steam customers require differing steam conditions, as follows:

BF Goodrich: steam pressure at least 260 psi immediately downstream of BFG's reducing station. BFG's needs are fully interruptible, with minimal notice.

University of Akron: sufficient pressure and temperature to provide 390°F high temperature water.

Akron City Hospital: dry, saturated steam of at least 125 psig, 350°F; solids content 3 ppm. Service to the hospital is interruptible, with notice; the hospital has back-up boilers.

Downtown Users ("steam loop" customers): various, controlled by regulators at the customers' locations. Steam to the regulators is dry, at 125 psig. With the exception of one hospital that is non-interruptible, users have at least a small back-up capability.

Ferrous metal production was projected to be 8.2% of feed material by the designer, and 6.0% of feed material by the reviewing engineers.

ACTUAL PLANT RATES

Because the system is still in startup, production rates have not become sufficiently steady to represent fully-operational plant performance.

Refuse Input

Refuse process/combustion has been irregular throughout the start-up period. Beginning in July of 1980, with two exceptions, more than 2,000 tons per week were handled. By October, processing regularly exceeded 3,000 tons per week. As of January, 1981, processing 4,000 tons per week had been achieved.

Product Output

Steam output has varied for operational reasons and due to seasonal demand. As of October, 1980, with Akron City Hospital not yet on line, steam production exceeded 20,000 M lb per week, or an average of nearly 120,000 lb/hr. In the first three quarters of 1980, between 10% and 20% of the steam generated at RES was produced by firing fuel oil. Since then, oil use has declined to occasional use as a supplemental fuel and for trimming. At present (April 1981), typical steam production is 200,000 to 220,000 lb/hr.

Ferrous metal recovery has been lower than expected, due both to low concentration in the waste stream (estimated now at 3% of incoming refuse) and to less than anticipated deliveries of waste. Approximately 2% of the incoming refuse is recovered as ferrous metal. The metal is sold as scrap to a local scrap metal handler at #2 bundle price (February, 1981, price exceeds $60 per ton in San Francisco) less $10 per ton. The purchase agreement does not specify a maximum acceptable level of contamination. Detinning of recovered ferrous has not been pursued.

Residue

In late September of 1980, approximately 1,000 tons per week of residue from RES were taken to the Hardy Road landfill. This represented about 30% of the waste processed, and included both ash and air classified heavy fraction.

PHYSICAL PLANT AND STAFF

Figure 2-3 shows a site plan for the facility. The area of the entire site is 7.85 acres, roughly half of which is occupied by buildings and associated roadways.

Materials Flow

Figure 2-4 is a flow diagram of the RES system. Refuse is brought to the facility by municipal or commercial haulers in packer trucks, transfer trailers and large open trucks. Material is discharged into a long rectangular pit through openings in the center of the tipping floor. Hydraulically powered rams in the pit floor move waste toward one end of the pit, which opens onto two metal pan conveyors. A boom crane is available for pushing refuse down onto the rams, preventing the waste from "bridging" above the rams. The pan conveyors carry waste upward to the feed of two horizontal-shaft shredders. The shredded waste is conveyed to an air classification system, in which air is introduced both to fluidize or suspend the material and to carry off the light combustible fraction. The heavy fraction passes a magnet which removes ferrous metal; the non-ferrous portion is loaded into transfer trailers and landfilled. Light combustibles, meanwhile, pass through a materials handling fan, are de-entrained in a cyclone, and fall into a large rectangular storage bin. Horizontal augers at the bottom of the bin propel the refuse-derived fuel (RDF) onto a conveyor; it passes through a surge bin feeder to rotary air locks and is pneumatically conveyed to the boilers' feed spouts. Ash and unburned material fall to a travelling grate; depending on particle size, the material may fall through the grate as siftings or be carried to the ash dump at the end of the grate. In either case, bottom ash remains dry and is loaded into trucks for hauling to landfill. Exhaust gases pass through the boiler and economizer, then into a four-field electrostatic precipitator. Water is added to the fly ash for dust suppression. Fly and bottom ash are disposed together. Steam is piped to customers, with a small amount used in-house to generate electricity for plant equipment.

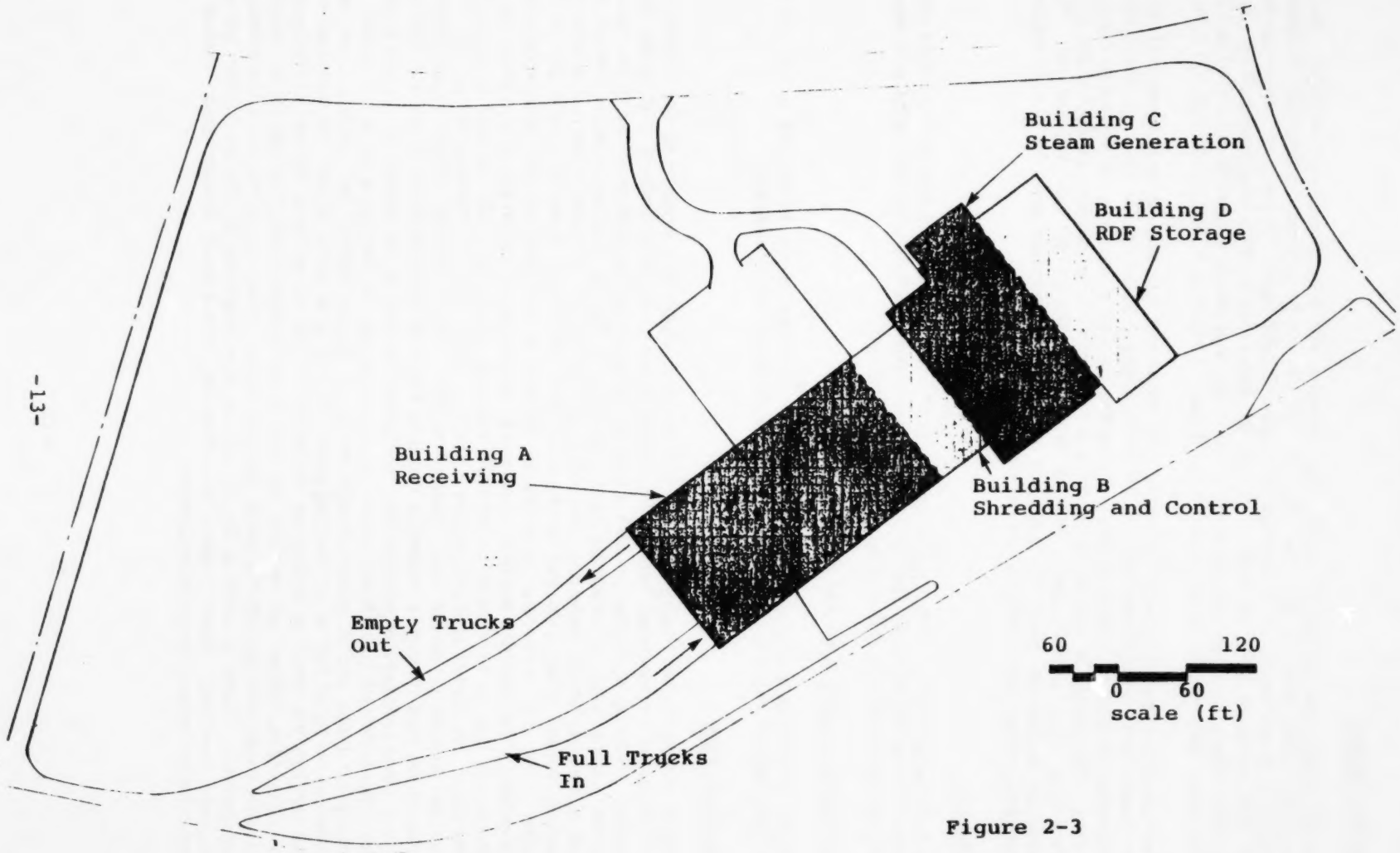


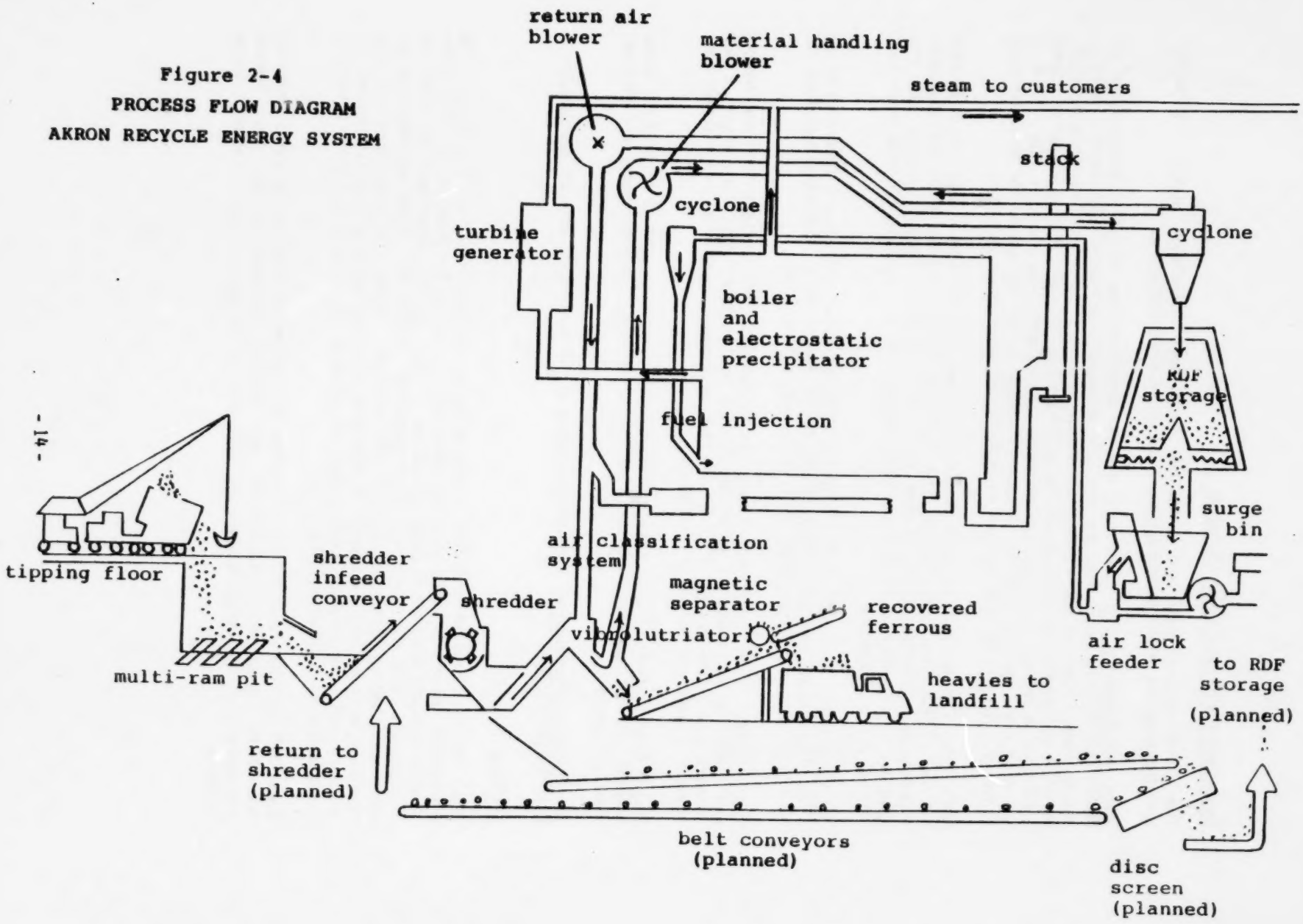
Figure 2-3

SITE PLAN

Figure 2-4

PROCESS FLOW DIAGRAM

AKRON RECYCLE ENERGY SYSTEM



Equipment Performance Specifications

The steam output flow and conditions have been mentioned above. Technical specifications for other major equipment items are discussed below.

Multi-ram Receiving Pit: Two rows, one per shredder line, of hydraulically-driven inclined ram feeders, eight units per row, are arranged in a manner similar to a reciprocating grate stoker. A peaked ridge divides the rows, and the sides of the pit are steeply inclined, so that the pit cross section has a "W" profile. Design capacity is approximately 1,800 tons of refuse. Each ram pushes waste forward and upward until it falls in front of the next ram (see Figure 2-5). Refuse eventually is carried off by the shredder feed conveyor. The ram system was custom-built by the construction company.

Shredders: The two units are from American Pulverizer, each with a feed rate of 60 tons per hour (TPH), rotor speed 720-900 RPM, 1,500 hp, horizontal shaft-type, with explosion suppression. Shredder grate spacing is 2-1/8" x 8-7/8". Output particle size was specified to be such that 100% would pass through a 6" x 6" opening, and 80% would pass through a 2" x 2" opening.

Air Classifiers: Each of the two Triple/S "Vibrolutriator" units has a feed rate of 60 TPH. The original technical specifications do not include any requirements regarding the quality of separation (heavy/light split, performance testing, etc.).

Fuel Storage: RDF is stored in a large double-sided bin with rectangular floor, having side walls that slant outward toward the bottom (Miller-Hofft type). Twin augers, a pair on each side of the bin, pull RDF toward the bin center, where it falls on two belt conveyors. Capacity of the bin is 1,900 tons.

Boiler Feed System: A pneumatic conveying system delivers RDF to each of the three boilers. Design rates of each are 17-20 TPH, assuming 2-4 pcf density and minimal glass/grit content.

Electrostatic Precipitator: The design loading of the gas output from the precipitator is 0.11 lb/MMBTU/hr.

Staffing

When the plant first came on line, a total of 58 people were required. This included ten managerial and office staff, with the remainder working in the plant itself. Four shifts of plant workers are used to cover operations 24 hours per day, seven days per week. As of October, 1980, the number of plant personnel totaled 85. Plant maintenance and start-up/shakedown activities caused this increase. When the plant goes into full operation, a reduction in personnel is expected; the final manning level is unknown, but probably will be somewhat greater than the original 58. Figure 2-6 gives a table of organization as of October, 1979.

Each shift includes licensed boiler operators as required by Ohio law. Workers have been trained by equipment manufacturers, and training continues on the job. Several engineers from the design engineering firm work in the plant to provide support during start-up.

Figure 2-5

MULTI-RAM DESIGN SKETCH

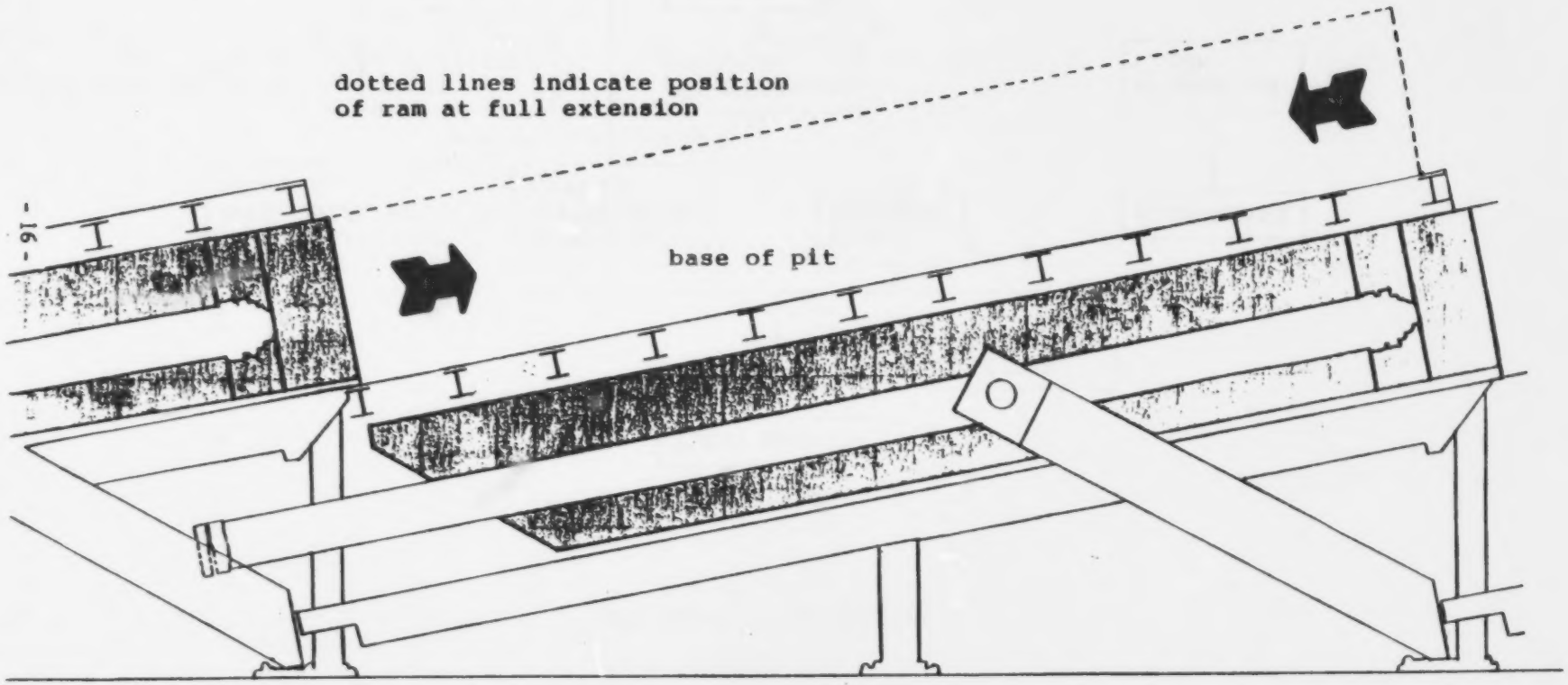
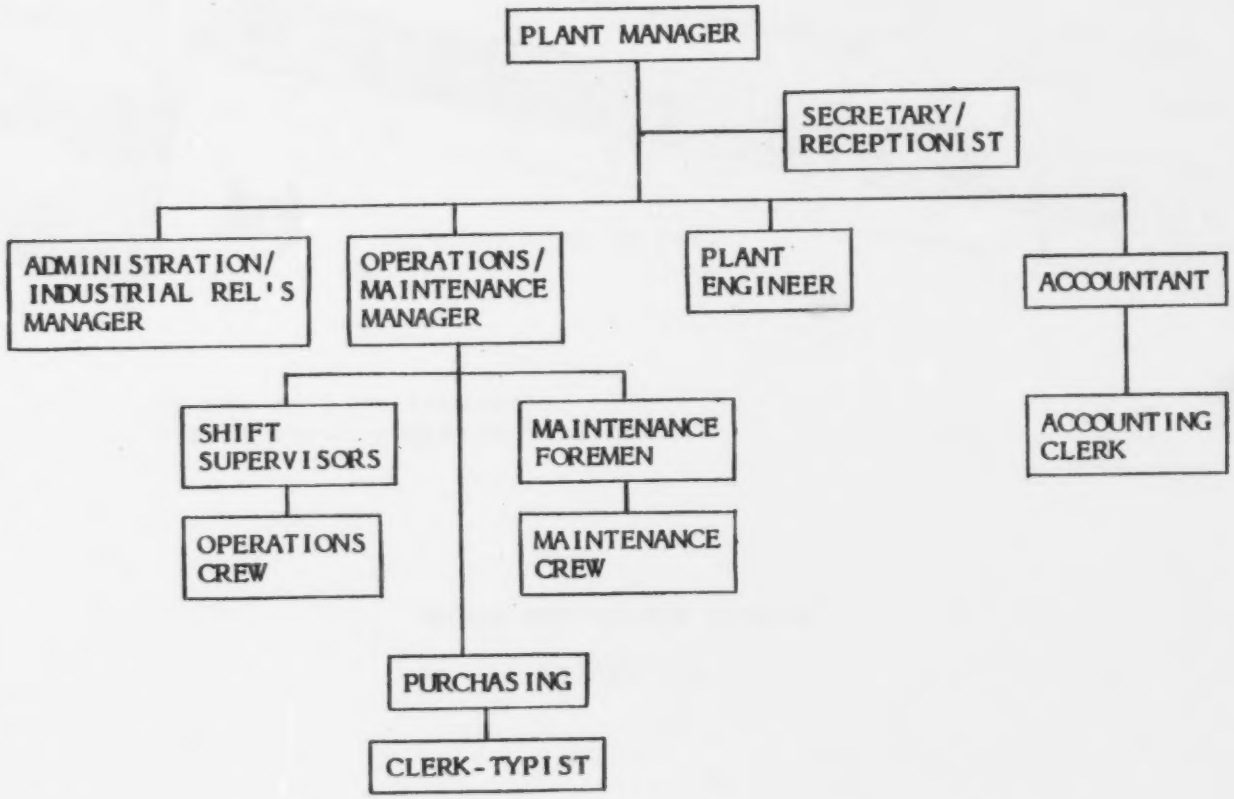


Figure 2-6

RES Staff Organization



CHAPTER 3 - PROJECT FINANCES AND RISK ALLOCATION

METHOD OF FINANCE

The method of finance for the Akron facility was a combination of tax-exempt revenue bonds and general obligation bonds. This structure reflected the underwriter's concern that the bond issue be as strong as possible; at that time New York City's default was a very recent memory. The largest amount, $46 million in tax-exempt revenue bonds, was issued by the Ohio Water Development Authority. This state agency provided substantial credibility to the issue. The $46 million was intended to cover the entire cost of construction start-up, and financing. Further support was provided by general obligation bonds of the City of Akron and the County of Summit, for $5 million each. These three parties signed a Cooperative Agreement and selected a Trustee, the Ohio Citizens Trust Company. The Trustee maintains several funds, including: 1) a Construction Fund; 2) a Contingency Fund; and 3) a Debt Service Reserve Fund. The $46 million issue supplied cash for these three funds. In addition, the $5 million from the City of Akron was placed in a Distribution System Construction Fund, and the $5 million from the County of Summit went into a Supplemental Construction Fund. A Debt Service Fund was also established to handle debt service monies, and an Equipment Replacement Fund was set up. The latter will be funded by quarterly payments from the City: $10,000 per quarter from 1980-1985, $100,000 per quarter thereafter.

Table 3-1 lists major project costs; direct construction expenses are broken down in Table 3-2. Note that no site preparation cost is listed; the site was cleared as part of a large federally-financed urban renewal project.

Prior to the bond issue, the City had made a considerable investment in engineering, permitting, drafting of specifications, etc. Federal revenue-sharing funds provided much of this investment, and the Akron Planning Department arranged for the use of these monies. This was done with the understanding that the revenue-sharing funds would be reimbursed from bond issue proceeds. As part of the City's initial investment, the Planning Department contributed several man-years of effort, including about 25% of its Director's time. To date, bond issue proceeds have been used to defray project costs rather than to repay the City's planning investment.

FINANCIAL PERFORMANCE

The RES facility has performed quite differently from its planners' expectations. Protracted startup activities have had a serious effect on the financial health of the project, forcing Akron to seek additional monetary support by various means. The following paragraphs describe both projected and actual revenues and expenses, to the extent that data is available. A diagram (Figure 3-1) illustrates the projected flow of funds through the project, for 1980. The expense for ash disposal is not shown; it is paid not from RES project funds, but from other City monies. The basic handling of funds, including billing of steam customers and refuse haulers, is performed by Teledyne.

Revenues

The sale of steam is by far the principal source of operating revenue in the original cash flow projections for the plant. Approximately three-fourths of the operating revenue is projected to be brought in by the sale of steam, over $6 million in 1980, escalating to $12.5 million in 2004 (see cash flow projection, Table 3-3). In fact, steam production in 1980 was too low to provide such a large income. Average monthly income from steam sales over the ten months ending October, 1980, was $140,000 per month; on a per-year basis, this would provide roughly $1.7 million. Figure 3-2 shows actual RES revenues through October 1980, plus projected revenues to December 1981, when the plant should be fully operational. Steam purchase prices, set in the various steam contracts, vary

Table 3-1

RES PROJECT COSTS

Expense Item	Amount	Source of Funds
Planning Dept. Feasibility Study	$15,000 (est)	City General Fund (Revenue-Sharing money, later reimbursed from bond issue)
Technical Feasibility Study	$20,000	BF Goodrich (solicited by City Planning Department)
Direct Construction Costs (see Table 3-2)	$34,160,000 (1 Jan 1980)	$46 million OWDA bond issue + $5 million city G. O. Bond + $5 million county G. O. Bond
Indirect Construction Costs (includes final design, specifications, legal, studies, engineering review, etc.)	$17,370,000 (1 Jan 1980)	
Start-Up Costs	$2,110,000 (1 Jan 1980)	

Note 1: Total pre-construction costs are estimated by City staff to total approximately $1 million.

Note 2: Start-up expenses through 1980 have exceeded $1 million; refinancing of the project has been initiated.

Table 3-2

RES DIRECT CONSTRUCTION COST BUDGET
(October 1979)

Expense Item	Amount
General Construction	$14,882,000
Mechanical Construction	3,627,000
Plumbing and HVAC	216,000
Electrical Construction	3,169,000
Steam Generators (Boilers)	8,488,000
Steam Lines and Tie-Ins	3,350,000
TOTAL	33,732,000

RECYCLE ENERGY SYSTEM PROJECT
PROJECTION OF OPERATING RESULTS
(All figures in thousands)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Tons of Solid Waste Processed	365	365	365	365	365	365	365	365	365	365
Operating Revenues										
Total Revenues from Sales of Steam	$ 6,220	$ 6,618	$ 7,012	$ 7,131	$ 7,265	$ 7,421	$ 7,606	$ 7,805	$ 8,000	$ 8,181
Total Operating Revenues	$ 8,179	$ 8,596	$ 9,009	$ 9,148	$ 9,302	$ 9,479	$ 9,685	$ 9,906	$10,124	$10,328
Operating Expenses										
Total Operating Expenses	$ 2,741	$ 2,863	$ 2,978	$ 3,134	$ 3,301	$ 3,476	$ 3,659	$ 3,854	$ 4,059	$ 4,273
Net Operating Revenues	$ 5,438	$ 5,733	$ 6,031	$ 6,014	$ 6,001	$ 6,003	$ 6,026	$ 6,052	$ 6,065	$ 6,055
Other Income	$ 885	$ 591	$ 317	$ 360	$ 398	$ 414	$ 415	$ 415	$ 415	$ 415
Total Funds Available	$ 6,323	$ 6,324	$ 6,348	$ 6,374	$ 6,399	$ 6,417	$ 6,441	$ 6,467	$ 6,480	$ 6,470
Debt Service Requirement	$ 4,200	$ 4,216	$ 4,232	$ 4,249	$ 4,266	$ 4,278	$ 4,294	$ 4,311	$ 4,320	$ 4,313
Funds Available after Debt Service for Reserve Funds	$ 2,123	$ 2,108	$ 2,116	$ 2,125	$ 2,133	$ 2,139	$ 2,147	$ 2,156	$ 2,160	$ 2,157

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Tons Proc.	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365
Op.Rev.															
Steam Rev.	$ 8,378	$ 8,581	$ 8,793	$ 9,028	$ 9,270	$ 9,509	$ 9,785	$10,073	$10,368	$10,688	$11,023	$11,376	$11,748	$12,142	$12,582
Total Rev.	$10,549	$10,776	$11,013	$11,274	$11,543	$11,809	$12,113	$12,430	$12,755	$13,105	$13,471	$13,856	$14,261	$14,689	$15,164
Op. Exp.															
Total Exp.	$ 4,499	$ 4,735	$ 4,987	$ 5,253	$ 5,533	$ 5,821	$ 6,139	$ 6,465	$ 6,811	$ 7,174	$ 7,559	$ 7,966	$ 8,394	$ 8,844	$ 9,328
Net Rev.	$ 6,050	$ 6,041	$ 6,026	$ 6,021	$ 6,010	$ 5,988	$ 5,974	$ 5,965	$ 5,944	$ 5,931	$ 5,912	$ 5,890	$ 5,867	$ 5,845	$ 5,836
Other Inc.	$ 415	$ 414	$ 414	$ 413	$ 412	$ 411	$ 410	$ 409	$ 407	$ 407	$ 405	$ 404	$ 402	$ 401	$ 401
Total Avail.	$ 6,465	$ 6,455	$ 6,440	$ 6,434	$ 6,422	$ 6,399	$ 6,384	$ 6,374	$ 6,351	$ 6,338	$ 6,317	$ 6,294	$ 6,269	$ 6,246	$ 6,237
Debt Svc.	$ 4,310	$ 4,303	$ 4,293	$ 4,289	$ 4,281	$ 4,266	$ 4,256	$ 4,249	$ 4,234	$ 4,225	$ 4,211	$ 4,196	$ 4,179	$ 4,164	$ 4,158
Funds for Reserve	$ 2,155	$ 2,152	$ 2,147	$ 2,145	$ 2,141	$ 2,133	$ 2,128	$ 2,125	$ 2,117	$ 2,113	$ 2,106	$ 2,098	$ 2,090	$ 2,082	$ 2,079

Figure 3-1

Flow Diagram of Project Funds, 1980 Projections
(All amounts in thousands)

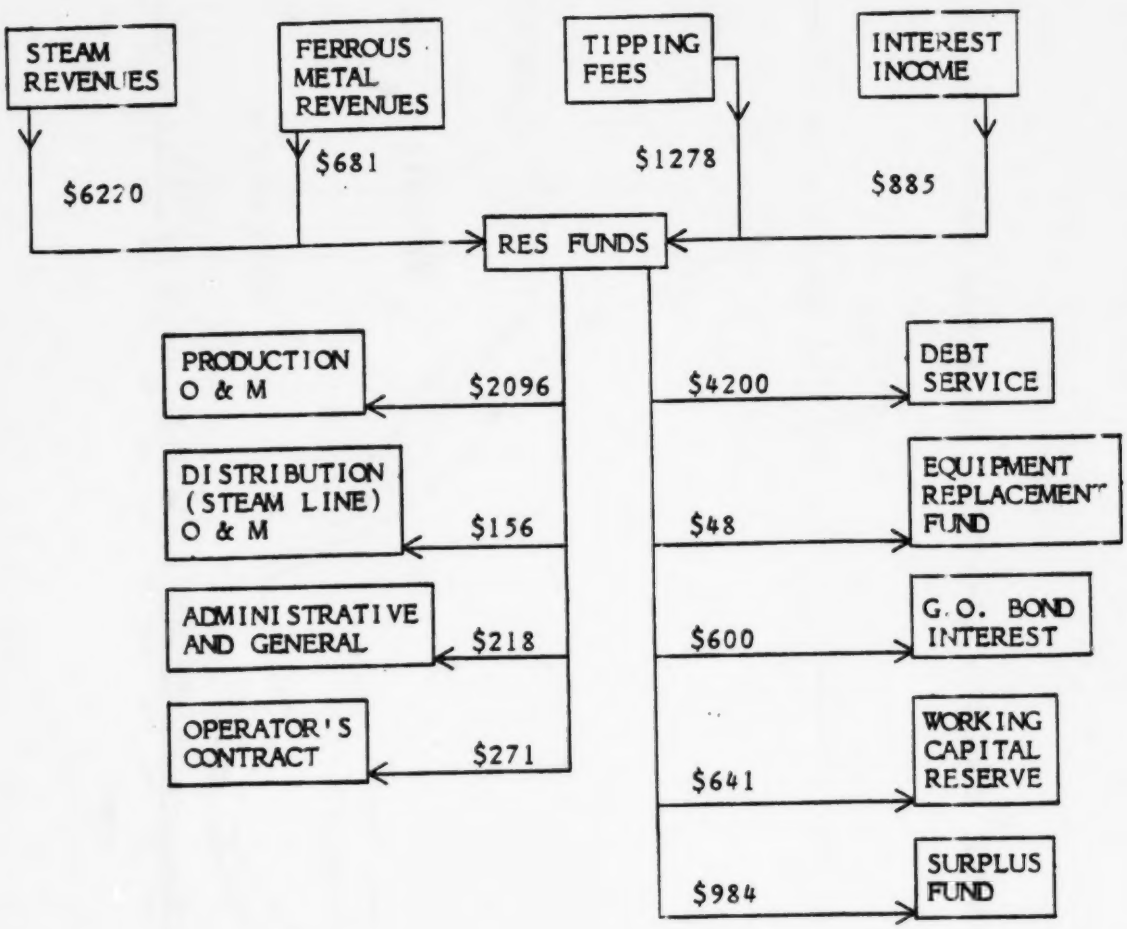
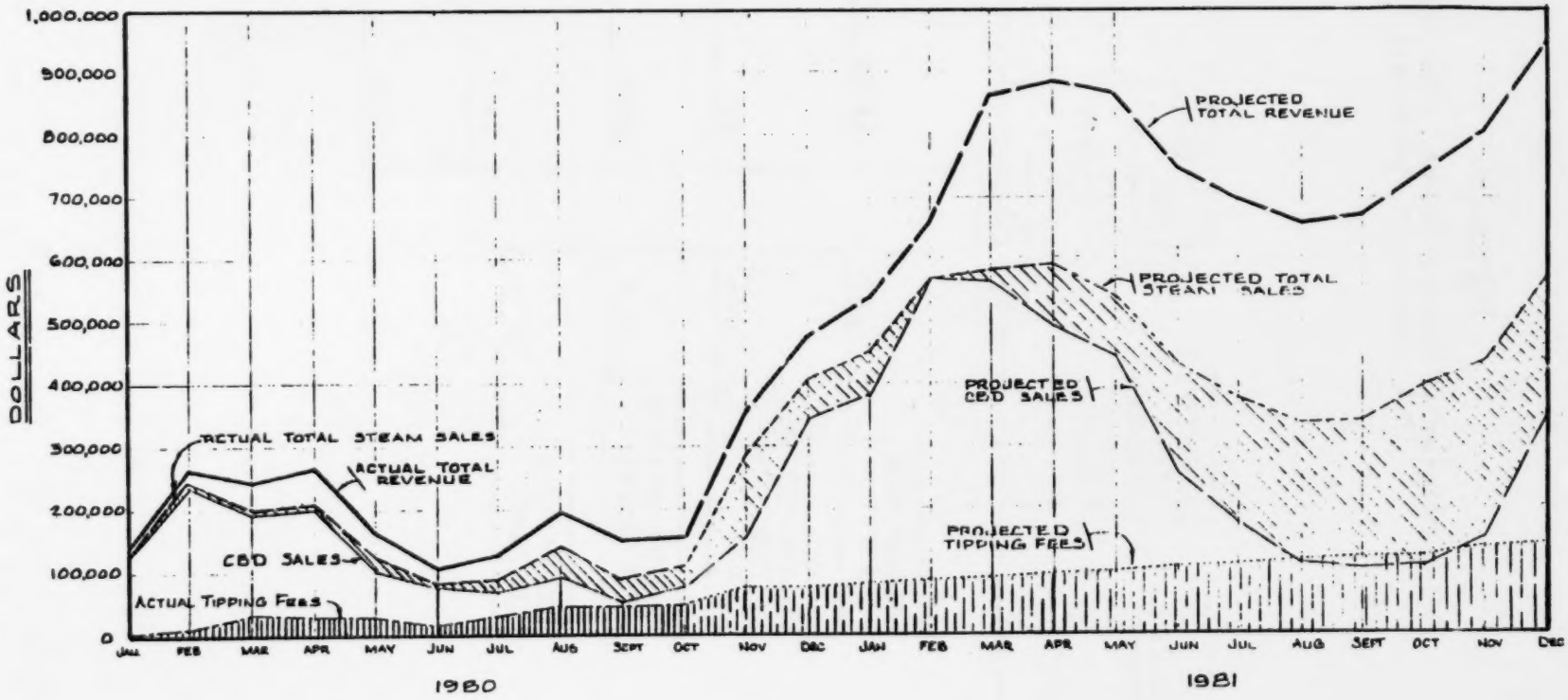


FIGURE 3-2

RECYCLE ENERGY SYSTEM REVENUE DATA PROFILE



from an original low of $1.83/M-lb paid by BF Goodrich, to over $4.00/M-lb for small purchasers on the downtown steam loop. The City expects to increase steam prices sometime in 1981.

A second source of revenue is tipping fees paid by refuse haulers bringing waste to the plant. The City as well as private haulers pays these charges. They are lower than for most similar resource recovery facilities, as the plant needs to attract waste from outside the City, and land disposal charges in the surrounding area are not high. The projected annual revenue of $1.3 million is based on an assumed tipping fee of $3.50 per ton, with 7,000 tons delivered per week. Actual monthly revenues in late 1980 were about $50,000 on deliveries of 3,000 tons per week. This, of course, is less than half of the projected income. The tipping fee at RES was recently raised to $6.00 per ton. The City's Hardy Road landfill tipping fee was raised to $8.00 per ton in January, 1981.

In the cash flow projections, sale of recovered ferrous metal is a minor source of revenue at first, escalating over the project lifetime (at 2.75%) until it exceeds the tipping fee revenue. Projected sales of $681,000 in 1980 were not realized. A more recent projection covering the last half of 1980 shows a revenue of $68,000 in that six month period. Lower total tons processed, lower market value, and lower percentage recovered are the reasons for this reduction.

Other income, from interest on reserve funds and notes, is projected at $885,000 in 1980, rapidly falling to about $400,000 per year over the life of the project. Actual amounts in this category have not been available for this report.

The oil entitlements program has provided indirect support to the project. Entitlements revenues, about $7 per ton of refuse, have been used by the City to defray ash hauling expenses. With the end of the entitlements program, this expense will be borne by the City.

Akron is seeking additional revenues for the project, in the form of a price support subsidy from the Department of Energy. If granted, this subsidy would amount to $2 per thousand pounds of steam in the first year, declining to zero over a five-year period. Based on September, 1980, steam production and waste processing rates (15,000 M-lb per week and 2,700 tons per week, respectively), this subsidy converts to over $11.00 per ton in the first year.

Expenses

In the early years of the project, the major expense in cash flow projections (see Table 3-3) is the debt service requirement of about $4.2 million per year. The first year's estimated operating expense is about $2.7 million; after 1990, total operating expenses exceed debt service. Since the plant is still undergoing modifications, no realistic operating data are available for comparison. It should be reported, however, that the extension for the startup period through 1980 required that the debt service reserve fund be spent to cover debt service in that year.

Operating and maintenance costs have been higher than expected. Through the first nine months of 1980, fuel oil was used to produce between 10% and 20% of the steam generated at RES, on the average. It had been intended in the design of the plant that fuel oil only be used if the normal supply of refuse was disrupted; clearly, fuel oil purchase costs are adding significantly to the operating expenses of the project. Fuel costs were initially projected at $1 million per year, but have been substantially more. High manning levels (69 hourly personnel, versus 32 expected) and high electric power costs

($50,000 to $60,000 per month) have pushed O&M costs to $150,000 per month. Staffing costs should decline as the plant becomes fully operational. Resolution of problems with the plant's generators (see Modifications, Chapter 4) should reduce expenses for purchased electricity.

The expenses for the steam distribution system, projected to be $156,000 in 1980, were in fact much less. For the second half of 1980, the plant operators estimated $55,000 would be spent.

As compensation for operating the plant, Teledyne receives direct reimbursal of costs, a flat fee of $150,000 per year, and 7% of steam sales. The operator also receives 50% of ferrous sales above a certain threshold, which has never been reached.

Expense Control: Ordinary purchases (less than $3,000) are paid for by the City, on a requisition-and-purchase-order basis. Items costing more than $3,000 must be approved by a City Board of Control. Expenses above $5,000 require City Council approval. Monies for all such expenses are drawn from the project trust funds.

RISK ALLOCATION

In this project, practically all risks are borne by the City, either directly or indirectly.

Waste Supply

The City bears this risk, in that it is obligated to provide steam to its customers and must use either refuse or fuel oil to produce that steam. Akron's waste control ordinance assures delivery of waste collected within the City to the plant.

Energy Market

Steam contracts between the city and its customers on the downtown loop require that all heating on the premises be supplied by the steam produced at RES. This portion of the energy market is assured. BFG is required to purchase all excess steam, up to their own energy needs (which are considerable). The BFG purchase price is relatively low both because they are interruptible on short notice and because they are such a large user. Akron City Hospital has agreed to purchase at least 165,000 M-lb per year, or be billed for the difference. The University of Akron's steam contract includes a similar "take-or-pay" provision. Both of these markets are interruptible, with adequate notice, and the City is not held to a "put-or-pay" requirement for steam delivery. In summary, the energy market risks are shared by the City and its customers.

Disposal of Residuals: The city bears this risk, and provides both the landfill site and the hauling service for the project. If the Hardy Road landfill should be exhausted or found unsuitable, the City will be required to find an alternative. This risk is a substantial one, and will no doubt receive greater attention from the City when the more immediate problems of day-to-day operations are brought under control.

Facility Construction: The City required construction contractors to furnish performance bonding as security. The City has borne all risk and expense for the many modifications in the original plant design.

Facility Operation: Teledyne is paid for plant operation on a "cost-plus" basis; they are reimbursed for costs and receive a flat fee plus percentages of steam and ferrous sales. Teledyne is not at risk, in this position, so long as they follow the operating guidelines set by the City. The risk of unsatisfactory operation is borne by the City, in the form of increased operating and maintenance costs and/or decreased steam revenue.

Debt Service: The bonds issued by the OWDA to support the project are revenue bonds; no pledge of the State, County or City's faith and credit has been made. In the event that the City defaults on payment of bond principal and interest, the trustee may either operate the plant or sell it to redeem the bonds. The City and County back the $10 million in general obligation bonds with their full faith and credit.

Air Emissions: The City risks all modifications which may be required due to emission limits.

CHAPTER 4 - PROJECT EVOLUTION

PLANT RELIABILITY

As a supplier of steam to downtown businesses and several hospitals (the sole steam supply for one hospital), high reliability is essential for the RES plant, especially through the winter months. To assure continuous operation, each of the three RES boilers was fitted with three steam atomized oil burners having high energy spark igniters, to be used in case the flow of refuse is interrupted. To process 1,000 TPD, all three boilers must be in service; the maximum processing capability of the plant is 1,140 TPD.

When unanticipated difficulties - detailed below - were encountered with firing RDF, the common operating practice at first was to keep one boiler on minimum-fire using oil alone, for rapid response to loss of RDF feed. This guaranteed that the steam needs of non-interruptible customers were met. However, increasing reliability of the system has enabled the operation to meet winter 1980/81 steam demands principally with all three boilers burning 100% RDF, with the use of fuel oil confined to supplemental fuel and trimming.

Availability

The plant is accepting refuse and producing limited quantities of steam. When start-up is completed and certification granted, a true picture of plant availability will be obtained. For the plant as a whole, it is expected to be greater than 90%. Taking into account the interruptibility of several major customers, availability at present is roughly 60%.

Down Time

Since the end of January, 1980, unscheduled down time (defined as zero steam production) exceeding a week has occurred only once, in mid-May of that year. Steam production has not shown a consistent increase since then, due partially to irregular demand and partially to technical problems. Here again, after the plant is certified, a more useful picture of down time in an RDF-dedicated boiler facility will be obtained.

MODIFICATIONS

Modifications to the plant have been numerous. This discussion covers the major changes, i.e., those that will influence the design of similar future facilities.

Bridging in Multi-Ram Pit

A persistent bridging problem has occurred in the multi-ram pit. When refuse is piled quite deeply, the rams push out waste at the bottom of the pile, but the refuse above forms an archway and does not slump downward. In effect, a tunnel is created below the bridged refuse. Rather than rework the pit design, a lower-cost solution has been adopted. A truck-mounted boom crane located on the receiving floor, with a plate attached to the boom end, is used to poke refuse downward, breaking up the bridge and assuring continuous feed.

Dribble From Shredder Feed Conveyors

At the discharge of the shredder feed conveyors, refuse was being dragged around the head of the conveyor and was falling to the floor below. Although only a small percentage of the total material was falling out as dribble, this could still amount to a ton or more in a day's time. Now, dribble conveyors route this material to the shredder discharge conveyor, completely bypassing the shredder.

Shredder Grate Spacing

When operated as installed, the shredders were not sufficiently reducing the size of feed material. Grates furnished with the shredders had openings of 8-7/8 inches x 8-7/8 inches; the specified size reduction (100% minus 6 inches) did not occur. Partitions were welded in the grate holes to reduce grate size to 2-1/8 inches x 8-7/8 inches. This solved the basic problem, and now only the most resilient objects maintain a large-size after shredding. These include long, thin textile strips, such as carpet trimmings, and plastic milk containers. Now that a more satisfactory grate aperture has been defined, cast manganese steel grates will replace the welded units, and grate life is expected to increase substantially. Experiments with replaceable hammer tips, to simplify greatly hammer changes, are proceeding.

Auger Operation

The augers at the bottom of the RDF storage bin frequently become entangled with wire and long textile. The solution has been to construct an enclosure within the storage bin, under which the augers are positioned when the problem becomes severe. A worker then cuts away wire and rags. Auger misalignment has presented operating problems. Recently, electronic load sensors have been installed on the augers to detect excessive strains.

Fan and Air Lock Wear

Problems have occurred in each of the two separate air conveying systems; the prime cause of these difficulties has been the abrasive character of the RDF. In the discussion that follows, it is helpful to refer to Figure 2-4.

Fan wear: RDF is conveyed from the air classifiers to storage in a low pressure push-pull system. Air, loaded with 30-40 TPH solids, is drawn through a material handling blower which pushes it to a cyclone, from where it is pulled by a return air blower, the solids having been de-entrained from the airstream in a cyclone. The first fan is subjected to heavy wear, and in spite of being fabricated from special abrasion resistant materials, the blades have to be changed approximately every ten working days.

Also, an airflow imbalance exists betwen the "push' and "pull" fans of the system. This has been alleviated substantially by removing all the blades from the "pull" fan.

Air lock wear: Fuel moves from storage, through an airlock feeder, into a high speed (90 fps) airstream, to the boilers. This is a medium pressure system. The size, density, and glass content of the fuel is not as projected, and severe wear on the airlocks has necessitated frequent and expensive rebuilding. The operator is redesigning these so that the wear parts can be replaced more easily and at much lower cost.

Pneumatic Duct Plugging

Bends in ducting carrying RDF from storage to the boiler are usually the site of a stoppage. This is most commonly caused by the occasional oversize object, such as a plastic milk jug. Blower horsepower has been increased from 100 to 140 hp, raising air velocity from 80 to over 90 feet per second, in an attempt to move the material without stoppage. This has had some success, but plant personnel recognize that wider ducts with fewer bends would provide a better solution. Use of belt rather than pneumatic conveyors has been discussed (see Future Developments, below).

Boiler Control

The boiler control system was designed to maintain constant steam flow. When demand increased, steam flow would rise; the system's response was to cut back on fuel, to reduce flow to normal (see steam chart, Figure 4-1). Control systems have been modified to maintain constant pressure; now, when increasing demand reduces steam pressure, the system increases feed to raise the pressure back to normal, thus correctly responding to the rising demand.

Ash Loadout

Bottom ash loadout is by manual rake-out. This is unusual in modern boiler practice and reflects concern that wire and other noncombusting tramp materials would foul automatic retrieval mechanisms. Personnel assigned to this very unpleasant task wear suitable respirators and protective clothing, but the high levels of dust, heat, and sparks generated in this operation are causing a re-examination of the loadout method.

Steam Coil Air Heater

As installed, this air heater served to heat overfire air which was drawn from the return air in the air classification system. That return air contained enough light particles to seriously clog the air heater with "lint." The solution has been to draw this air from the atmosphere rather than from the air classifier return.

Waste Heat Economizer

The waste heat economizer, which exchanged heat from stack gases to a hot water building heating system, has been taken out of service, because it proved to be both unnecessary for space heating and subject to corrosion problems.

Turbogenerator Exhaust

The plant is fitted with two turbogenerators having total generating capacity of about 4 MW; these will operate the entire plant, if necessary, except for startup of the shredders. However, exhaust from the turbines created a serious noise problem. Only a part of the turbine exhaust could be brought through the deaerator unit, which effectively muffles the noise and also makes use of the waste heat. As a result, only a portion of the generating capacity was used. Once the rest of the exhaust was rerouted through the boiler vents, which exhaust the steam silently, the remainder of the generating capacity could be used.

IMPACT ASSESSMENT AND COMPLIANCE

The Ohio EPA determined that an Environmental Impact Statement would not be required for the RES plant. Therefore, no general document addressing environmental impacts was prepared.

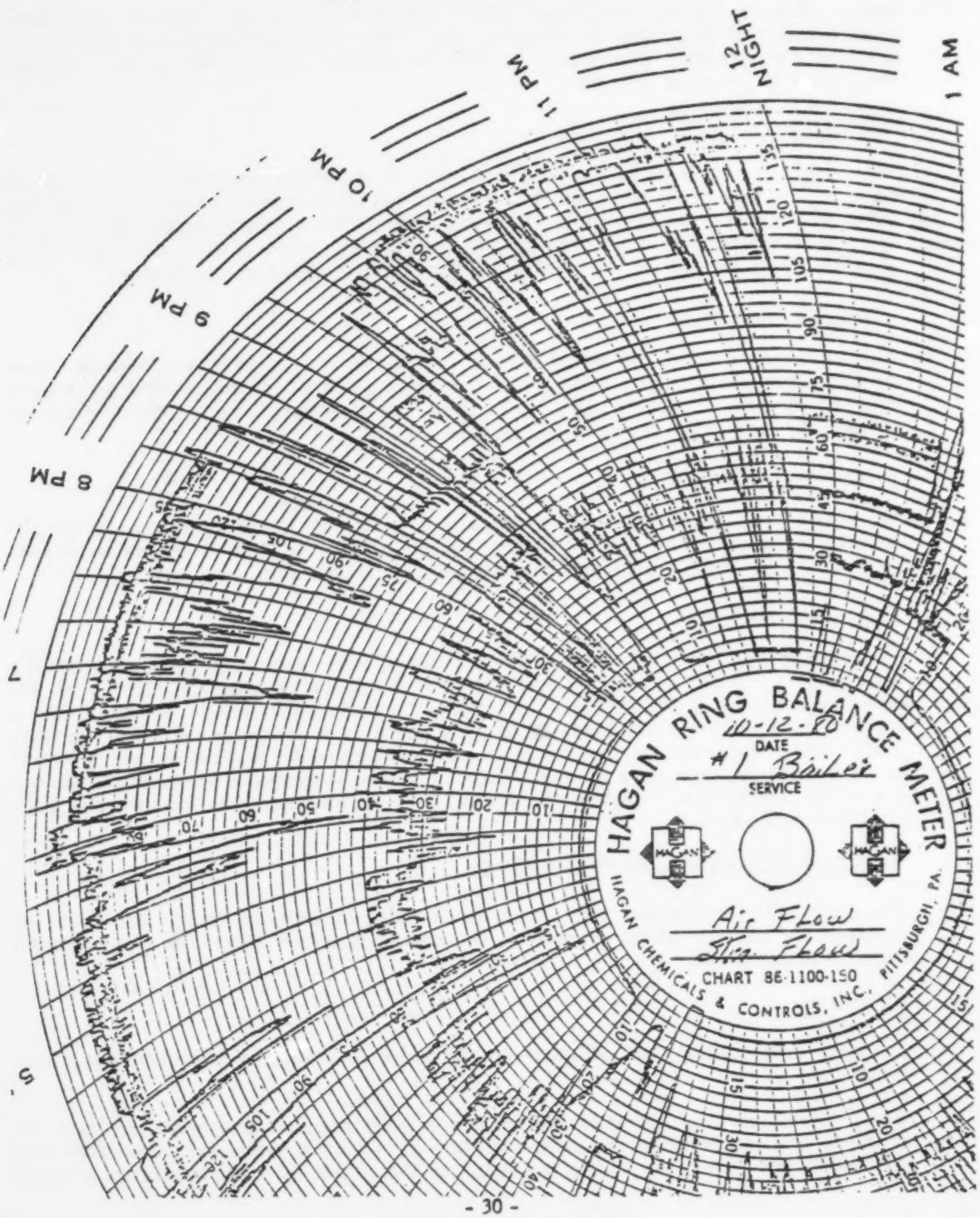
Air Quality

To date, three distinct air pollution problems due to emissions from RES have been identified.

Odor: During start-up, the plant has sometimes been unable to process refuse for a day or more. The raw refuse in the multi-ram pit has given off a noticeable odor. More odor complaints have been due to decomposition of the stored RDF, which has on occasion

Figure 4-1

SAMPLE RES STEAM TABLE



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been allowed to stand for several days. Originally, the problem was aggravated by air escaping from the plant; this was unforseen in the design, which attempted to provide a plant interior air pressure lower than atmospheric pressure. As operating experience has increased, limiting RDF and raw refuse storage and keeping doors closed to control plant air have alleviated the odor problem.

Particulate in Stack Gases: One set of opacity readings taken by the local air pollution control district in mid-1980 exceeded 60% for nearly half of the one-hour sample time. Increased operating experience and modification of boiler controls have largely, but not entirely, eliminated this problem. Particulate testing will not be carried out until start-up is completed.

Lint-like Particulate: Businesses and residents in the area have complained of small, fibrous particles given off by the plant. The probable cause of these emissions is air vented from the air classifier system. Exhaust was originally open to the atmosphere; it is presently vented through a screened enclosure.

Residue Disposal

The Ohio EPA found disposal of ash at the City landfill to be acceptable. No leachate collection is required.

Noise

Residents and businesses near the facility have complained of excessive noise. Some of the noise problems have been due to start-up activities which will not continue when the plant is fully operational. The City of Akron does not have a noise ordinance; the issue of compliance is unclear.

Traffic

Traffic at the plant has not been a problem, nor is it likely to be as the amount of refuse processed increases. Existing roadways are adequately sized, and truck traffic is consistent with the industrial character of adjacent sites. The area surrounding the plant and its immediate neighbors is a mixture of residential and commercial use buildings.

Private vehicles will not impact traffic near the plant. When the Hardy Road landfill is closed to private vehicles, the City will establish one or more waste disposal centers, where individuals can drop material for hauling to RES.

SUCCESSES, FAILURES, REMEDIES

Steam Markets Obtained

Chief among the successes of this project is the signing of several major steam purchasers. It was the securing of this market base that made financing of the plant feasible. The insistence of Dillon, Read that this be done and the skill of City negotiators in securing these buyers deserve equal credit.

Education of Decision-Makers

The Department of Planning and Urban Renewal did a capable job in educating the Mayor and City Council as to both the need for a system like RES and the features of such a system. This was accomplished in part by visits to refuse processing plants then operating in the United States.

Explosion Suppression

Prior to October, 1980, one minor explosion had occurred in the refuse shredders. Because designers had allowed for the possibility of explosion, there were no injuries, nor any need for major repair work. The design of the RES plant reflects an early low level of concern for explosions, followed by a great deal of concern brought to the project by GPD, Teledyne, and the insurance underwriters. The control room is located directly over the shredders, providing a good view of the waste being fed, but still uncomfortably close to the source of an explosion. Shredders are fitted with Halon and waterfog sprays, which are triggered by an explosion shock wave. Color television gives operators a close look at material on the shredder feed conveyors, and a pedestal-mounted boom crane simplifies removal of hazardous or oversize material from the feed. There are water sprays over the shredder feed conveyors which may be activated manually or by a smoke alarm. Large vents lead laterally from the shredders through the exterior walls of the plant. Finally, flue gas is circulated through the shredders, reducing the oxygen in the shredder to limit an explosion.

Boiler and Grate Design

Both the boiler and the traveling grate have performed well; tests in the plant have pushed the boilers above rated capacity by as much as 20% without incident. Problems with boiler controls have been discussed in the Modifications section of this chapter.

Processing Problems

There have been a number of operating problems in the plant during shakedown. The solution to most of these has been to modify particular equipment items. These changes have been discussed earlier in this chapter, under Modifications.

Air Pollution

Emissions violations and complaints have occurred while the plant has been in start-up; these have been discussed in the preceding section. The operator has taken steps to reduce or to eliminate these problem emissions.

Operator Participation

Teledyne National was accepted as project operator literally at the last minute. The favored candidate, Hooker Chemical, did not have sufficient support from within its own corporate structure at that time and had to withdraw. When Teledyne was accepted, the plant design was virtually complete and Teledyne's first involvement was in plant construction. In hindsight, most parties to the project agree that any qualified plant operator should be given the chance at least to provide input into the design that they will be expected to operate.

Financing

In arranging financing for construction and startup, Dillon, Read required a commitment of $5 million each from the City and County, over and above the projected cost of $46 million. This additional $10 million proved to be essential in taking the plant through more than a year of start-up (three months had been scheduled) and providing time to arrange for still more start-up financing.

FUTURE DEVELOPMENTS

City staff has not yet identified all of the sources of 1,000 TPD of municipal refuse which will be required when the plant is fully operational. However, several steps to assure an increase in delivery to RES have been taken. These include the waste control ordinance (discussed in Chapter 1) and a lower tipping fee at RES than at the Hardy Road landfill ($6.00 versus $8.00, as of January, 1981). As the plant approaches full operation, additional measures will probably be needed to attract sufficient waste from elsewhere in the greater Akron area.

An important future development will be the resolution of a court case concerning the Akron waste control ordinance. The U.S. Sixth District Court has upheld the ordinance; this decision has been appealed.

With regard to the processing plant itself, a number of future modifications are likely. Teledyne and Akron have recognized the need either to remove glass and other abrasives from the refuse, or to handle a much more abrasive fuel than was anticipated. Unless most of glass and other abrasive materials can be removed from the wastes, the pneumatic portions of the processing system may have to be replaced with belt conveyors. Plans presently call for use of a disc screen to remove oversize material from shredded refuse, returning the oversize fraction to the shredder feed. Belt conveyors rather than pneumatics will be used to convey material from the shredder discharge to the disc screen and for taking screened fuel to the storage bin. The air classifier will be bypassed. Belt conveyors may also have to be used to carry fuel from the storage bin to the stokers. This would eliminate all pneumatic conveying lines; the abrasives content of the RDF could not change.

At least one unit will have gas burners installed during 1981, to take advantage of the lower cost of natural gas versus #2 fuel oil.

The construction and start-up period will officially end when the plant demonstrates its capability by operating continuously at a full level of service for three months. Plant management estimates that this will be achieved by December of 1981.

CHAPTER 5 - THE CALIFORNIA PERSPECTIVE

INTRODUCTION

In this chapter, the Akron project is examined with respect to its viability as a resource recovery project in California. Particular attention is paid to the issues of ash disposal and air pollution, and to the permitting process.

PROJECT LOCATION

Akron is an industrial midwestern American city, surrounded primarily by farmland, with the major metropolitan area of Cleveland roughly 30 miles north. It has a long history of heavy industry, chiefly tire manufacture. Seasonal temperatures and weather conditions vary widely through the year. There is no geographic equivalent of Akron in California.

From an environmental point of view, the dissimilarity is equally strong. Coal has been the traditional fuel for industry in the Akron area, and the resulting air pollution is thought by the USEPA to contribute to acid rain in neighboring states. In this region, relatively simple controls on air and water emissions can have a significant positive impact. California metropolitan areas, in contrast, already have taken basic measures to control air pollution, and new sources of emissions must apply very sophisticated controls in order to comply with regulations. In short, compliance with environmental regulations is simpler in Ohio.

ASH DISPOSAL

Plans to dispose of RES ash at the Hardy Road landfill have had the full approval of the Ohio EPA. This landfill is probably the equivalent of a California Class II disposal site. Acetic acid leachate tests sponsored by Teledyne (presumably similar to standard USEPA methods) and performed on fly ash and bottom ash show more heavy metals leaching from unprocessed refuse than from bottom ash; from fly ash, however, both barium and zinc were found to leach in appreciable quantity. The combining of fly ash and bottom ash for hauling to the landfill may act to mitigate this leaching. These test results are included in documents submitted to the California State Solid Waste Management Board as a part of this study (see Appendix B).

In contrast, incinerator ash is considered a hazardous waste under existing California regulations. It must be disposed of in a Class I or approved Class II-1 landfill, which is likely to cost far more than the $8/ton tipping fee at Hardy Road. If the Akron project were to move to California and operate successfully with an adequate steam market, it would still face a difficult economic situation due to the high cost of ash disposal.

AIR POLLUTION

Akron is a non-attainment area for SO_x, particulate, hydrocarbons, and carbon monoxide. The regulatory agencies concerned with RES generally perceive the plant as achieving a substantial offset, in that it burns #2 fuel oil or refuse-derived fuel and it replaces coal-burning units at BF Goodrich and Ohio Edison's steam plant. No formal offset requirement or New Source Review was imposed, as the application for a permit to install the plant was submitted before those regulations went into effect. If the same project were to be attempted in California today, considerably more air pollution control equipment would be needed than the RES four-field electrostatic precipitator. Recommendations of the California Air Resources Board (CARB), published in their report "Air Pollution Aspects of Resource Recovery," are the major cause of concern. The CARB finds that Best Available Control Technology should be required on resource recovery plants now proposed for construction in California; that BACT for particulates is a

baghouse which limits emissions to 0.01 gr/dscf; for oxides of sulfur and acid gases, flue gas desulfurization systems with 90% efficiency; for oxides of nitrogen, selective catalytic devices or wet NO_x scrubbers (probable BACT; determination not yet final).

The Akron Air Pollution Control Agency (APCA) has principal responsibility for air emission regulation of the RES plant. This local agency, created in 1965, serves a three-county area. The APCA has been delegated the power to enforce state and federal EPA regulations. When the RES plant is certified, the APCA will require an EPA Method 5 stack test to assure that particulate emissions do not exceed 0.05 gr/dscf corrected to 12% CO_2. The agency also enforces a stack gas opacity limitation of 20%. The APCA does not recommend air pollution control technologies to industry, but will assist in finding solutions to air pollution control problems within its district.

WASTEWATER

Plant wastewater originates from boiler blowdown and water softener regeneration. This type of discharge is high in total dissolved solids (TDS). The wastewater is discharged to the municipal sewer system. For a similar project sited in California, some pre-treatment, such as chemical precipitation, might be required if the TDS concentration and effluent flow rate would disrupt an existing water treatment plant, although this possibility is not very likely.

STATE SOLID WASTE MANAGEMENT AGENCY

Involvement of the Ohio EPA in the RES project apparently has been minimal, except for the activities of the Akron Air Pollution Control Agency, as described above.

PERMIT PROCESS

The application procedure for RES's Permit to Install was greatly simplified by the fact that air, water and solid waste permitting are all handled by the Ohio EPA; only one state-level application was necessary, with sub-parts to address concerns regarding boiler, incinerator, and solid waste disposal facility operations.

After shakedown is completed, RES must apply to the Ohio EPA for a Permit to Operate. This is structured similarly to the Permit to Install.

Local permits such as building and site permits were prepared internally by the City.

Certainly, if a similar facility were proposed for California, a great many more permits would be required. The coordination of permits would occupy one person's attention through the planning, design, construction, and start-up phases. New Source Review rules, air quality management district permits, Prevention of Significant Deterioration permit, NPDES permit, stack height permit, solid waste facility permit, county solid waste management plan revisions, and various other state and local permits would be required. The effect of these permit requirements is to increase the costs of project implementation, and in some cases to cause delays. Akron was fortunate not to have to bear this expense. For a California project, the cost of employing a permit coordinator is easily justified when compared with the cost of possible construction or operating delays due to problems with permit coordination.

CHOICE OF SYSTEM

The majority of large-scale energy recovery systems considered or selected in recent years have been of the "mass burning" type, without extensive refuse-derived fuel (RDF) preparation prior to incineration. In the early 1970's, the relative advantages of mass burning and RDF preparation systems were not well established, simply because the technologies had not accumulated much operating experience in this country. Some of the respective advantages of the two systems are listed below. The advantage of low ash production for RDF systems is particularly noteworthy due to the anticipated high cost of ash disposal in California.

Advantages of Mass Burning System:

Mechanical and operational simplicity

Prior experience with systems in Europe, Japan

No need for intermediate fuel storage or surge capacity

Applicable with smaller tonnage

Advantages of RDF System:

Fuel is smaller and more homogeneous in size (quicker burnout)

Shorter response time for combustion control

Elimination of some noncombustibles prior to burning (reduced ash)

Opportunity for materials recovery (aluminum, glass)

Opportunity for co-firing with other fuels (such as biomass)

OTHER CONSIDERATIONS

Local Citizen Use

As designed, the RES plant is not accessible to the general public (for safety reasons). The City of Akron recognizes that provision must be made for public use of the plant; an adjacent drop-box station is envisioned. A similar arrangement should be considered in California, where citizen use of local landfills is usually a significant fraction of the total traffic.

Financing

To finance the RES plant, the City sought a state agency as bond issuer, to provide additional credibility for the project. The Ohio Water Development Authority filled that role (the City remains the owner of the facility). In California, a different financial approach would have to be used. If a city wished to retain ownership (as Akron has), it could issue revenue bonds or lease revenue bonds, provided that its city charter and ordinances were structured to permit this approach. Since Proposition 13 has disallowed ordinary general obligation bonds, the only other low-interest-rate form of financing available to cities in California is a bond issue secured by a pledge of certain sales and use taxes.

Waste Composition

The principal difference between the compositions of municipal solid waste in California and Ohio is that the Ohio refuse has a much larger seasonal variation with respect to yard waste. The effect of this variation on RES plant performance is as yet unknown. It is clear, however, that the large quantities of grass clippings processed during certain summer months have severely reduced the selectivity of the air classification system and caused frequent plug-ups in the air ducts. In addition, certain types of industrial waste, such as uncured rubber (unique to Akron), have caused shredding problems.

Waste Control

For Akron, this issue has been settled at the District Court level, with the upholding of Akron's waste control ordinance, although an appeal is pending. Akron's waste control ordinance prevents recovery of materials from the waste by the collection/transfer companies. This was done to assure an adequate supply of fuel to the RES plant. All "solid waste" must be routed "through the project." Collection of source separated materials may have to be aranged through a separate franchise, so that those materials are not termed "solid waste."

Under their home rule powers, municipalities in California should be able to impose waste flow restrictions similar to Akron's. Such restrictions would probably survive legal challenges based on constitutional and antitrust arguments. However, waste control ordinances might conflict with existing or planned recycling programs.

CHAPTER 6 - PROJECT EVALUATION

PROJECT BENEFITS

The RES project provides several benefits to Akron. Energy is supplied to City users at a reasonable cost. Landfill life is extended. Air pollution from existing steam plants is eliminated or reduced, with an expected net reduction in emissions. Employment is provided for over 60 residents of the Akron area.

PROJECT-RELATED PROBLEMS

Many of the technical difficulties being experienced in this plant are the result of abrasion and wear due to the presence of glass in the shredded refuse. A simple means of eliminating that glass would be to install a trommel prior to the shredder. Unfortunately, the existing layout does not permit that sort of retrofit. The absence of a trommel or disc screen, and the use of pneumatic conveying where belt conveyors are more appropriate, are the principal design problems in the plant.

A problem that has not yet become well-defined is the need for additional refuse at the plant. As the facility's processing capability has improved, and trucks have been turned away less frequently, more refuse has become available to RES; apparently, haulers needed time to gain confidence in the plant's reliability before shifting routes and schedules. However, for 7,000 tons to be delivered to the plant each week, it probably will be necessary to attract waste to the City from other parts of Summit County, and perhaps from outside the County. Enough landfill space will be available in the county to compete with the project, unless RES tipping fees are kept low.

The waste control ordinance poses a problem for local proponents of materials separation and recovery. Unless the ordinance is amended, or RES begins materials recovery, materials separation will be hindered by the ordinance's requirement that all collected waste be brought to RES without separation of recyclables.

UNEXPLOITED OPPORTUNITIES

There are two sources of fuel available to RES from the industrial community. Scrap tires exist in abundance in the Akron area, and Teledyne has found that they could be shredded and added to refuse to enhance its fuel value. Also, disposal of liquid wastes at the facility has been investigated in a preliminary way, and some thought is being given to installing a fourth unit for this purpose. Of course, the design of that fourth unit would differ significantly from the other three, as the existing three units are inappropriate for the firing of liquid wastes.

HINDSIGHT EVALUATION

The various participants in this project gave differing answers to the question, "If the project were to begin again, what would you do differently?" The architects and engineers pointed out that more time should have been taken by the City to draw up the conditions of operation and to select an operator (only 1½ months were taken). The City would have brought in a financial consultant, and would prefer not to have the waste control ordinance on the books (which the underwriters had insisted upon). The operators indicated various design problems, previously discussed, which they might have eliminated if involved in design. Both the City and its steam customers stated independently that they would have bargained a little harder for more favorable steam prices. The one change in approach on which there was general agreement was the need to involve the facility operator in plant design, or at least in review of the design. Cogeneration of electric power has been mentioned by more than one party as a possible option for the future; but at the time of design and construction, regulations then in effect did not require cooperation from the local utility, and such cooperation was not then likely.

APPENDIX A - FIELD INSPECTION NOTES

GENERAL QUESTIONS

- Background: What provided impetus?

  two problems:
  difficulty anticipated in siting new landfill
  need for steam supplier for downtown heating

- Benefits of the project?

  steam supplied to downtown Akron and BF Goodrich
  net reduction in air pollution
  reduced fossil fuel consumption
  reduced landfill demand

- Does it solve the problem?

  yes - to the extent that the system approaches operating capacity (50% now)

- Does it cause any other problems?

  air emissions: odor, particulate (solvable)
  waste control ordinance issue and litigation

- If the same project were begun today, what would differ?

  design would include trommel, no pneumatics
  financial consultant brought in early
  operator involved with design of system or single design/build/operate responsibility

- Role of State Solid Waste Agency?

  cooperative; approved project without hesitation

- Local governments - how cooperative?

  City owns the project
  outlying communities interested in sending waste (exception: Cuyahoga Falls)

- Waste Supply - how obtained?

  waste control ordinance for City of Akron: 750 TPD
  competitive tip fee for other communities

- Unexploited opportunities for energy/material recovery?

  cogeneration (was not feasible when project was designed)

- Critical factors in development of the plant.

  No citizen objection during development

  Boosts: new legislation, citizen support, corporate backing

  citizen support and recognition very high
  BF Goodrich provided initial study funding
  State agency (OWDA) issued bonds

PLANNING - STUDIES

1) Title

Title	By	Cost	Fund Source
Regional Waste Disposal Study	City	unknown (1971)	general fund
Feasibility Study	GPD	$15,000 (1971)	BF Goodrich
Solid Waste . . . Akron Area	City	unknown (May 1974)	

2) Alternatives Investigated

Continued Landfill
Regional Landfill
RDF/Dedicated Boiler
RDF/Supp. Fuel

3) Wastes Considered

Type	TPY	Avg. TPD
City of Akron	270,000	750
Outlying communities	90,000	250

4) Technology Recommended: RDF to dedicated boiler

Reason: better control of combustion than mass burning

5) Future Considerations

2-5 years

Waste Increase: should not exceed 1,000 TPD

Disposal Methods: burn at Recycle Energy System (RES)

5-15 years

Waste Increase: may exceed 1,000 TPD

Disposal Methods: fourth unit at RES

PLANNING - GENERAL

1) Risk Allocation

Type of Risk	Entity Assuming Risk	How Assumed
Waste Supply	City	Ordinance
Energy Market	City	Contracts
Disposal of Residuals	City	Owns & Operates Landfill
Facility Construction	City	Construction Contracts
Facility Operation	Teledyne	Operating Agreement
Debt Service	City	Indenture to OWDA Bond

2) Impetus

Disposal Problem - new landfill unavailable
Economic Development - preserve City center
Energy Demand - from downtown users and Goodrich

3) Citizen Participation

Committees (formed or existing)
Steam Users Advisory Committee

Local governments involved
Akron, Wadsworth, Cuyanoga Falls

Public Meetings: Number, Sponsor, Purpose
No public meetings per se
Many presentations to civic groups

Citizen Complaints
Complaints of odor, lint, droplets

4) Recycling Programs - Prior, Existing and Planned

Typical "paper drive" activity
Some separation of corrugated paper at local transfer station

5) Anticipated Effect of Recycling Program on Energy or Material Recovery

Minimal

6) Site Selection

Used urban renewal land closest to steam line and BFG

OPERATION

1) Feedstock

Composition not analyzed

Heat Value

RDF: 5,900-6,300 BTU/lb

2) Throughput

Design - 1,000 TPD_7
Actual - 500-600 TPD_7

3) Energy Output (note variability)

Steam: 378,000 lb/hr (rated) 560°F saturated

% Availability

90%, including oil-firing, when certified

60% at present

4) Materials Outputs

Type	Flow Rate (TPD) Design	Actual
Ferrous metals		Not yet established, estimated 2% of incoming refuse is recovered

5) Residuals (indicate point of removal from process flow)

Type	Flow Rate	Disposal Cost	Distance to Disposal Point
Air-Classifier Heavies	25% of input	$45/20 tons (haul)	8-10 miles
Ash	15-20% of fuel tonnage	+ $6/ton (dispose)	

6) Plant Energy Use

From Internal Sources: Two 2 MW turbogenerators can supply most plant power; use 60,000 lb/hr. Also steam is used for preheating feedwater and combustion air and for space heating.

From External Sources: Electric power as needed

7) Process Flow (corrected diagram)

See Figure 2-4

8) Modifications

See Chapter 4, Modifications section

9) Maintenance

Requirement	Interval
Boiler inspection	Annual

Maintenance requirements for unit processes will be reduced as modifications are implemented.

10) Traffic

	Mon - Fri	Sat & Sun
General Public	None	None
Collection	80-100 vehicles per 10 hour day	Few to none

FINANCE

1) Project Initial Cost: See Table 3-1

2) Annual Operating Costs: Facility still in shakedown

3) Annual Revenues: Projections given in Table 3-3

4) Financing

Construction

Amount	Type	Term (Dates)
$46 million	Tax-exempt revenue	1975 through 2004

Preparation Entities	Firm(s)	Time (Dates)
	Prescott, Ball & Turben	1974-76
	Dillon, Read & Co.	1975-76

Cash Flow Projection — See Table 3-3

Plant Life

5) Funds Spent Prior to Releasing Bonds

Item	Origin of Funds
Initial Feasibility Study	City General Fund
GPD Technical Study	BF Goodrich ($15,000)
Design and Specifications	City Revenue Sharing Funds ($1 million)

6) Procurement Process

Bids received February 20, 1975
Delay due to financing difficulties
Bids accepted December 1976

7) Acquisition Approach - conventional

Reason for choice: City had had success with this approach for other projects.

8) Markets

Steam markets - See Contracts and Prospectus

9) Tipping Fee

Before Recovery	After Recovery (Now)
$3.50/ton	$6.00/ton

10) Method of Charging Disposal Cost to Users
Monthly billing, done by Teledyne

11) Waste Supply Agreements - none

PERSONNEL

1) Operating Crew (3 Shifts per Day, 7 Days per Week)

Classification	Number (All Shifts)
Boiler Operators & Helpers Mechanics General Labor Receiving Crew Electrician Instrument Tech	39

2) Maintenance Crew (3 Shifts per Day, 7 Days per Week)

Classification	Number (All Shifts)
Maintenance Mechanics Welders Distribution Line	30

3) Support Personnel (1 Shift per Day, 5 Days per Week)

15 total: Plant Management, Engineers, Reception, Clerk/Typist

4) Training Program

Boiler Operators licensed by State of Ohio
Teledyne will pay employees' tuition up to $300 per semester

5) Background of Management

Plant Manager on board since May 1980
Formerly worked in Firestone Plant, Akron

6) Safety Record:

Shredder Performance; Other Potentially Hazardous Equipment

One major shredder explosion

Other Comments

Typical industrial injuries; no major accidents

7) Union(s)
Closed Shop
Negotiation History
United Rubber workers elected, June 1980
Negotiations ongoing
Teledyne negotiates contract

8) Average or Typical Term of Employment

Operating history too brief

Turnover in skilled trades is high

ENVIRONMENTAL CONSIDERATIONS

1) Permits (Local, State, Federal)

	Type	Agency
- To Construct	Building	City
	Permit to Install	OEPA
	Spill Prevention Control	USEPA
	NPDES	OEPA/USEPA
- To Operate	Permit to Operate	OEPA

Starting Date for First Permit: December 1975
Completion/Renewal Date for Last Permit: Permit to Operate, not yet issued (March, 1981)

2) Exhaust Gases

Flow Rate	Control Measures
	4-field electrostatic precipitator

Pollutant Concentration Data - not yet sampled

3) Wastewater

Source	Flow Rate	Control Measures	Receiving Body/System
Boiler blowdown Water treatment		None	City sewer

4) Noise Measurements (Interior & Exterior)

In compliance with OSHA

5) Odor: Complaints from local citizens and nearby commercial establishments.

6) Aesthetics: Building exterior exceptionally well designed.

APPENDIX B - BIBLIOGRAPHY

LIST OF REFERENCE DOCUMENTS

ARTICLES
- Harvard Study, "Appropriate Technology for Community Development," May, 1979
- 1977 summary, by City of Akron Director of Finance
- 1971-77 review of newspaper articles from Akron Beacon-Journal
- U.S. Conference of Mayors draft case study
- Various technical papers, ASME & others
- RES fact sheet, 03/26/79
- RES pamphlet, November, 1980

MAPS
- Downtown area, Akron
- Urban renewal: 2 maps

STUDIES

Supply of Solid Waste in Summit County	August, 1980
Solid Waste Management Plan for Summit County	December, 1979
Recycle Energy System (by GPD)	December, 1977
Feasibility of Processing & Using Rubber Tires as Fuel	September, 1977
Synopsis of Solid Waste Research Reports	1968-1977
Feasibility Report - RES (by Beck)	November, 1976
Preliminary Report - RES (by GPD)	June, 1974
Solid Waste Disposal in Akron Area (by City)	May, 1974
Feasibility Study (by GPD)	August, 1971
Comprehensive Regional Waste Disposal Study (by City)	July, 1971

PROPOSALS
- see "CONTRACTS" for draft proposal by GPD

PLANS/SPECIFICATIONS
- see "CONTRACTS"
- also, a complete set of plans furnished by GPD

ENVIRONMENTAL DOCUMENTS (EIR/EIS/NEGATIVE DECLARATION)
- none

PERMITS & REGULATIONS (chronological order)
- Pit ash analyses, fly ash analyses
- Correspondence regarding odor, ash & other issues/complaints
- Waste liquid fuel - letter by Ohio EPA
- Ohio EPA Permit to Install
- Application for Permit to Install
- City of Akron Table of Organization
- Contract empowering Akron Air Pollution Control Agency
- Air pollution control program assessment; brochure; information sheet
- Waste control ordinance

PROSPECTUS
- Ohio Waste Development Authority, $46 million

LETTERS OF INTENT
- none

CONTRACTS
- RES proposal
- RES instructions & conditions
- RES technical specifications
- Agreement by Edison to buy R.E.S. steam, July 1979
- Consultants Agreement, R.W. Beck
- Option Agreement: Edison to sell to Akron
- Cooperative Agreement for Construction, Maintenance, Operation; OWDA & Akron
- Agreement: City of Akron and BF Goodrich (steam purchase)
- Agreement: City of Akron and University of Akron (steam purchase)
- Agreement: City of Akron and Akron City Hospital (steam purchase)
- Agreement: City of Akron and First National Tower (steam purchase)

GRANT APPLICATION
- RES proposal for price support assistance - executive summary (to DOE)

FINANCING, OTHER
- Sample requisition
- Entitlements revenues
- Financial reports
- Cash flow projections, production projections
- Steam chart

OPERATIONS
- Implementation CPM schedule
- System timetable
- "Problem areas" article, Akron Beacon-Journal
- September 21 meeting notes
- Flow diagram
- RES organization chart

Harvard University, Department of City and Regional Planning Workshop, "Appropriate Technology for Community Development," May 15, 1979, Chapter 5, p. 301-356.

This study places emphasis on the role of the Recycle Energy System in revitalizing Akron's central business district. Technology is briefly discussed, in lay terms, and planning and financing aspects are given a thorough treatment. The political framework for the project is described. This is a fairly well done introduction to the RES system, with one shortcoming: the authors simply repeat information as they received it, with little emphasis placed on strengths or weaknesses of the project.

U.S. Conference of Mayors, "Akron, Ohio - A Case Study of Economic Development and Resource Recovery," Draft report, June, 1980.

The Conference of Mayors' case study is professionally done, including a number of photographs and a summary and chronology (Appendix A) that will be of value to community planners. A thorough description is given of the legal actions taken in Akron regarding waste control, and of other unique features of the Akron project. The technological aspects of the project are only described in general terms, and difficulties encountered in shakedown are not discussed.

Hileman, G.P., and Pyle, F.B., "Recycle Energy for Central Heating and Process Steam," paper presented to International District Heating Association, June, 1977.

Denchik, M. et al, "Akron Recycle Energy System is On-Line," paper presented to ASME National Waste Processing Conference, May, 1980.

These two technical papers thoroughly describe the engineering of the RES plant. The first gives cost estimates and projections, and the second gives a very detailed treatment of construction costs. The first paper briefly discusses some community planning, financing and marketing aspects of the project, while the second describes the plant and its construction in engineering terms.

Teledyne National, "Feasibility of Processing and Utilization of Rubber as a Fuel in the Akron RES Boilers," September, 1977.

This report concludes that waste rubber could be used in conjunction with RDF in the Akron system, with a relatively low fuel preparation cost ($0.32/MMBTU, 1977 dollars). Cost of the waste rubber would be additional. The several tire manufacturers in Akron area, and other sources of waste rubber, were surveyed by Teledyne; approximately 542 tons per week of waste rubber were estimated to be available to the project.

City of Akron Department of Planning and Urban Renewal, "Solid Waste Disposal in the Akron Area - Summary Report," May, 1974.

This brief report, prepared in 1974, summarizes a comparative study of various waste disposal options. Options include landfill, incineration, composting, pyrolysis, rail haul, Recycle Energy System and others; criteria include ease of siting, proven technology, flexibility, public acceptance, and others (17 total). The criteria are not strictly independent, and they are not weighted as to relative importance. The comparison table shows RES the clear favorite, and the report recommends that the City proceed with construction of the system.

City Council, Akron, Ohio, "Ordinance No. 842-1976 Authorizing Cooperative Agreement . . . ," passed October 4, 1976.

This ordinance accepts as binding the terms of the cooperative agreement between the Ohio Water Development Authority, the County of Summit, and the City of Akron, thus establishing the institutional and financial structure of the project. It further grants easement of project land and permission to construct and maintain steam lines under city streets. The City is empowered to set steam rates, and establishes rights of access and auditing. Perhaps most importantly, by authorizing the cooperative agreement, the City establishes powers of waste control, i.e., all refuse collected by the City or its franchisees must go through the project.

Dillon, Read & Co., "Official Statement of the Ohio Water Development Authority," description of $46 million bond issue, 1976.

The Statement gives background information on the RES project to support the sale of $46,000,000 in tax-exempt revenue bonds by the Ohio Water Development Authority. This bond issue, together with $5 million each in general obligation bonds from the City of Akron and the County of Summit, provided construction and start-up financing for the plant. Included is a feasibility report by R.W. Beck and Associates. This very thorough document, includes descriptions of the site, the engineering, estimated construction costs, permits, steam customers and contracts, and unsigned potential customers. Summaries of the steam contracts are particularly detailed, and would be useful to proponents of other projects if only to show the range of agreements which are possible.

Glaus, Pyle, Schomer, Burns & DeHaven, "Recycle Energy Systems Technical Specifications," October, 1974.

The technical specifications are several hundred pages of detailed description of the RES plant and its mechanical components. They were written as part of the bid package, which also includes drawings and other informative documents. Divisions of the specifications include: 1) general construction (of which Section 16 describes the refuse processing and RDF handling equipment); 2) mechanical work, including equipment ancillary to the boilers; 3) plumbing; 4) heating, ventilation and air conditioning; 5) electrical; and 6) steam generating equipment.

City of Akron, Department of Planning and Urban Development, "Recycle Energy System Proposal for Price Support Assistance - Executive Summary," August, 1980.

This application summarizes the progress of the RES project through August of 1980. The need for additonal funding is based on the costs incurred in resolving "technical difficulties" within the processing plant. Akron states that if they were to pass the costs of plant improvements on to their customers in the form of higher tipping fees or steam prices, the customers would seek other alternatives for waste disposal or energy supply. The support requested totals $11 million, and covers a five year period, declining each year as steam prices and tipping fees increase with fuel costs.